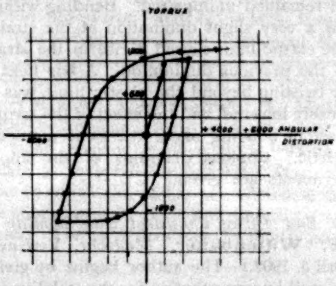
SCIENCE ABSTRACTS.

PHYSICS AND ELECTRICAL ENGINEERING.

OCTOBER 1902.

GENERAL PHYSICS.

1811. *Iron and Steel under Torsional and Combined Stresses.* **E. G. Coker.** (Roy. Soc. Edinburgh, Trans. 40. pp. 263–293, Nov. 12, 1901.)—Accurate work on the torsion of iron and steel has generally been limited to wires; and in these, want of roundness, and the hardening due to the drawing, would have an effect on the behaviour of the specimen. By means of his apparatus for accurately measuring torsional strain, the author has made a series of experiments on turned bars of about ½ in. diameter, subjected to pure torsion and to torsion combined with tension or with bending. The form of the stress-strain curve for pure torsion, and especially the form at the yield-point, were first investigated; according to the usual theory, if the material changes from the elastic to the plastic condition at the yield-point, the maximum torque which the bar will stand, when it is all plastic and subject to the same shearing stress, is four-thirds the value at which the first marked deviation from perfect elasticity occurs, for if q be the shearing stress which obtains throughout the bar in the first case, and at the outer layers only in the second case, $T_1 = \frac{2}{3}\pi q r^3$ and $T_2 = \frac{1}{2}\pi q r^3$. With an iron bar, the deviation occurred at 375 in. lbs., and failure at 525 in. lbs., ratio 1·4; a steel specimen gave 675 and 870, ratio 1·29. The phenomenon of breakdown and subsequent recovery from overstrain is similar in torsion to that in tension, such a moderate heating as 100° C. having a marked effect in promoting the recovery. The diagram shows the result



of an experiment on twist in alternately opposite directions on a wrought-iron specimen 0·634 in. diameter, length under test 4 in. The stress-strain curve is approximately linear until the yield-point is reached; the return curve is less so, but, as soon as torsion is applied in the negative direction, the linearity disappears. Breakdown occurs at about 1,100 in. lbs. On reversing the torque again, the curve is again linear until zero torque is reached, when it begins to bend over. The process was continued; each cycle having a hardening effect upon the bar, widening its limits of endurance with a final limit of 1,750 in. lbs., which was reached after fourteen reversals of the stress; the bar was now found to be cracked in several places along the minute seams of impurities. This experiment demonstrates that the limits of elasticity do not remain in their original positions, since stress carried beyond the elastic limit in one direction reduces the other limit to zero. The theory that a twisted bar is twice as strong to resist torsion in the same direction as in the opposite one is not borne out by the experiment. The idea that the distance apart of the elastic limits is a constant, appears to have no physical basis for iron in torsion. The effect of tension on torsion is next examined. A tension within the elastic limit has practically no effect on the elastic part of the torsion curve, but causes a distinct lowering of the yield-point. Two precisely similar pieces from the same bar were used, and a tension of 17,900 lbs. per sq. in. lowered the yield-point from 385 to 360 in. lbs. A specimen of steel was examined both before and after having a tensional stress beyond the elastic limit, producing a permanent set of 0·18 in.; its behaviour was quite linear at the first test, but the tensional overstrain entirely altered its torsional properties, for the second curve begins to bend over at a very low torque. The effect of torsion on tension was only examined below the elastic limit, Ewing's extensometer being used to measure the tensional strain. No difference was observable, whether the bar were twisted or not, provided the elasticity of the bar remained unimpaired. Bending within the elastic limit caused, like tension, a very slight diminution of the strain per unit torque. Bending beyond the elastic limit caused a rise in the strain per unit torque, much greater than the previous diminution. A bar bent within the elastic limit, and tested by twisting beyond the elastic limit, was found to have its yield-point considerably lowered, and the effect of the torque was to give the bar a permanent set in bending under the same moment to which it had previously been elastic. Copious diagrams of the apparatus and of the results of the experiments are given. H. R. C.

1812. *Maximum End Thrust Consistent with Stability for Rods fixed at several Points.* **F. Wittenbauer.** (Zeitschr. Vereines Deutsch. Ing. 46. pp. 501–504, April 5, 1902.)—The author begins by giving a new method of deducing Euler's well-known equation for the stability of a strut, assuming the end thrust symmetrical. The rod may be fixed at any number of points. He supposes the rod to receive a sideward disturbance at any point, equivalent to a statical force Q. Then the deflection at that point, in consequence of Q and the end load P, he shows to be always of the form $f = i\mathrm{QM}/m^3\mathrm{N}$, where $i = 1/\mathrm{EI}$ and $m = \sqrt{\mathrm{P}/\mathrm{EI}}$, E denoting the Young's modulus of elasticity and I the least moment of inertia of the (constant) cross-section. Further, if $l_1\, l_2\, l_3$, &c., are the lengths between the fixed points of the rod, a the distance from a fixed point of the point of application of Q, and if we put $ml_1 = \lambda_1$, $ml_2 = \lambda_2, \ldots, ma = \alpha$, then M is a function of $\lambda_1, \lambda_2, \ldots, \alpha$ and therefore involves the position of the disturbing force Q, while N is a function of $\lambda_1, \lambda_2 \ldots$ but not of α. If Q is infinitesimally small, then the deflection f

will be indeterminate, provided $N = F(\lambda_1, \lambda_2 \ldots) = 0$. This last equation enables m to be calculated, whence, from $m = \sqrt{P/EI}$, we obtain the thrust P, which, even for infinitesimal disturbance Q, gives a deflection of indeterminate amount. The advantage of the method is its facility of application to rods fixed at several points. The author illustrates by applying the method to two well-known and five new examples. W. S.

1813. *The Navipendulum.* **G. Russo.** (Engineering, 73. pp. 520-524, April 18; and pp. 590-593, May 2, 1902. Paper read before the Institution of Naval Architects.)—This paper deals with an experimental method of ascertaining the rolling of ships on waves, the process being founded on the principle of mechanical similitude. The first part of the apparatus is the "navipendulum"; it consists of a pendulum of special shape, and represents the vessel; artificial resistances are added to it till experiment shows that the loss of amplitude in each oscillation is the same for the navipendulum as for the vessel which it represents. The rolling of the pendulum on a fixed horizontal plate represents the rolling of the vessel in still water. The inclinations of the navipendulum are transmitted to a registering apparatus by means of a system of articulated pieces designed so as not to affect the free oscillations of the navipendulum, and introducing only very slight resistances. The second part of the apparatus is the wave-motion apparatus; the plate on which the pendulum rests is given a motion which corresponds on a reduced scale to that of a portion of the surface of the wave, considered as trochoidal; the construction of this apparatus is described in a paper read by the author at the 1900 spring meeting of the Institution of Naval Architects. The method of using the apparatus is fully described, and the interpretation of its indications critically discussed. Full results are given for navipendular experiments relating to the Royal Italian battleships *Re Umberto* and *Regina Margherita*, and to H.M.S. *Revenge*, ships of three different classes. The indications of the instrument have proved reliable. W. S.

1814. *Rotation of Lamina in Air Currents.* **A. Mallock.** (Nature, 65. p. 510, April 3, 1902.)—Angular velocity = const. × air speed v/breadth of lamina b. Very small laminæ (goldleaf 0·1 × 0·02 or 0·03 in.) do not revolve, but oscillate as they fall through air. The cause of the rotation depends on the way in which the eddies are formed on the downstream side of the lamina; the spin causes the air to flow unsymmetrically with regard to the axis of the lamina. For more than half the total time the rotation is being accelerated. A. D.

1815. *Reduction of Observation Equations.* **W. H. Keesom.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 14–19, May 31, 1902.)—This paper deals with the method of least squares for the case of several observed quantities occurring in the equation, the mean result being that from the observation equations reduced to a linear form:—

$$X_1 x + Y_1 y + Z_1 z + \ldots F_1 = 0,$$
$$X_2 x + Y_2 y + Z_2 z + \ldots F_2 = 0, \text{ \&c.},$$

the normal equations may be deduced in a manner analogous to the case in which the quantities $F_1, F_2 \ldots$ are taken directly from observations. In those equations $X_1, Y_1, Z_1 \ldots$ are a set of approximate values of $X, Y, Z, \ldots, x, y, z, \ldots$

are the corrections to be found, F_1, F_2, are special values of F, where the equation—

$$F(L, M, N, \ldots ; X, Y, Z \ldots) = 0,$$

represents the relation between the quantities L, M, N . . . , as measured directly, and the quantities X, Y, Z . . . , to be calculated. The mean error is found by the usual method. A. G.

1816. *A Numerical Relation between Light and Gravitation.* **V. Wellmann.** (Astrophys. Journ. 15. pp. 282–286, May, 1902.)—The author has attempted to explain the Newtonian law of gravitation by means of a gaseous ether of extreme tenuity, whose particles possess velocities of the order of the velocity of light. [See Wellmann, Astronomische Nachrichten, 144. p. 121, 1897, and 148. p. 169, 1899.] The Newtonian law has, on this supposition, to be modified if the attracting masses are in relative motion. The modifying factor is very nearly unity, and it involves the velocity of the ether particles, V. The author assumes in the present paper that V is equal to the velocity of light in vacuo, and hence deduces the so-called "factor of gravitation." It is found to be in numerical agreement with the constant of Gauss. The author says that the agreement is so close that "a merely accidental coincidence of the two values is out of the question, and a causal connection between light and gravitation seems to be expressed in the figures." W. S.

1817. *A New Hygrometer.* **E. Salvioni.** (N. Cimento, 3. pp. 390–392, May, 1902.)—The author describes a saturation hygrometer which may be used for determining the tension of aqueous vapour in the air in small spaces, such as instrument cases: a portion of the air to be examined is withdrawn and saturated with aqueous vapour, and the increase of pressure thus caused is noted; knowing the saturation vapour pressure, we can then deduce the aqueous vapour pressure of the experimental air. The apparatus consists of a bronze receiver fitted with a thermometer: into the receiver passes a glass tube drawn out at the lower end and connected at the upper end with a syringe which serves to force in drops of water. The receiver may be put in communication with the exterior air, and carries at the side a graduated tube of 3·2 mm. diameter, containing a column of petroleum 2·5 cm. long. The tension of aqueous vapour in the air enclosed in the receiver is equal to $B_0 - (\iota - \gamma\delta + \mu X)(B - T)$, where B and B_0 are the final and initial atmospheric pressures respectively, X is the displacement of the petroleum column, δ is the change of temperature during the experiment, $\gamma = 0{\cdot}0037$, μ is the ratio of the volume of 1 cm. of the side tube to that of the receiver.

D. H. J.

1818. *Demonstration of Change of Pressure with Change of Altitude.* **E. Salvioni.** (N. Cimento, 3. pp. 389–390, May, 1902.)—A cylindrical receiver of sheet metal, of the capacity of 1 to 3 litres, is immersed in a bath of water, and carries horizontally a tube of small section containing a column of petroleum. To conduct an experiment, the division opposite the end of the petroleum column is read when the apparatus is at a certain height (division b_0), again, when it has been raised through, say, 1 metre (division a_1), and again, when it has been brought back to the original altitude (division b_1). If readings are made at equal intervals of time the displacement will be $\frac{b_0 + b_1}{2} - a_1$. The theoretical displacement $= \frac{T - 1}{m}$, where $T = p_1/p_2$, if p_1 is the pressure at the lower position, p_2 at the higher position, and m the ratio of the volume of 1 cm. of the side tube to the volume of the receiver. The experiments made showed a concordance with the theory for isothermic dilatations and contractions. This concordance shows that with the arrangement adopted, the contractions and dilatations are not adiabatic, but strictly isothermal. D. H. J.

1819. *Mountain Masses and Latitude Determinations.* (Nature, 66. pp. 80–82, May 22, 1902. "The Attractions of the Himalaya Mountains upon the Plumb-line in India. Considerations of Recent Data," by **S. G. Burrard.**)—The principal reference station for latitudes in India is Kalianpur, lat. 24° 7′ 11·10″. From an examination of 148 stations available for geodetic investigations, General Walker had concluded that this latitude was too great by 2″, and that the plumb-line was there deflected to the south in reality, and not to the north. Since then, latitude determinations have been completed by L. Conyngham for four stations about 9 miles, and for four more about 35 miles from Kalianpur. The resulting deflections, both in the meridian and in the prime vertical, do not confirm Walker nor the assumption of any direct influence of the Himalayas. Burrard further discusses the influence of the oceans on the derived longitudes, and comes to the conclusion that the Indian observations favour the Clarke spheroid. H. B.

1820. *Wind Velocity and Fluctuations of Water-level on Lake Erie.* **A. J. Henry.** (U.S. Weather Bureau, Bull. 262. pp. 11–22, 1902.)—The longitudinal axis of Lake Erie, which has a length of 250 miles, approximately coincides with the direction of the predominating winds from the west and south-west. The paper reproduces the hourly records of wind direction, velocity, and lake levels for the year ending November 30, 1900, concerning the two stations, Amherstburg at the western extremity, and Buffalo at the eastern extremity of the lake. Wind measurements are not made at Amherstburg. [See Abstract No. 2137 (1900).] Particulars are given of the three great storms of Dec. 12, 1899, Sept. 12, 1900 (the Galveston hurricane), and of Nov. 21, 1900, the worst storm of that year, when the wind velocity reached 80 miles, and the water rose at Buffalo by 8 ft. 4 in. between 6 a.m. and 4 p.m. The water generally recedes as soon as the maximum wind velocity is passed. Rhythmic wind gusts favour a rocking motion of the water; a characteristic case occurred on August 21, 1900, when the wind velocity fluctuated between 11 and 17 miles per hour. Continued rockings were observed on the days September 12 to 15. The rare easterly winds produce a comparatively strong effect; the reasons for this peculiarity are not discussed. H. B.

1821. *Dust-Falls and their Origins.* (Nature, 66. pp. 41–42, May 8, 1902. From the Abhandlungen d. Kgl. Preuss. Meteorolog. Instit. II. No. 1, by **G. Hellmann** and **W. Meinardus.**)—Comments on the authors' memoir: "The Great Dust-Fall of March 9 to 12, 1901, in North Africa, Southern and Central Europe." Coarse particles fell in Algiers and Sicily without rain, finer particles later in Italy, the Alps, Austria-Hungary, Germany, Denmark, and Russia, in the order named, only with rains, to the total amount of about 1,800,000 tons, two-thirds of which mass was reported south of the Alps; the distribtion was irregular in streaks and patches. The dust was neither cosmic nor volcanic, and is traced back to dust-storms that occurred in the desert of El Erg, Southern Algeria, on March 8 to 10. H. B.

1822. *Mont Pelée Eruption and Dust-Falls.* **W. J. S. Lockyer.** (Nature, 66. p. 58, May 15, 1902.)—The eruption occurred on May 8, where Martinique lies in a low-pressure belt between two high-pressure areas over the Atlantic and South America, and where the sun culminates near the zenith. The ascending air-current from the low-pressure belt would carry dust with it, which, re-descending over the high-pressure areas in a spiral moving clockwise over the middle Atlantic, would reach Great Britain with a south-west wind. We might, therefore, hear of dust-falls and remarkable sunsets in this country. H. B.

1823. *Motor driving for Astronomical Cameras.* (West. Electn. 30. p. 322, May 10, 1902.)—This is a reprint of a part of the report presented by **A. E. Burton** to the Massachusetts Institute of Technology on the eclipse expedition to Sumatra on May 18, 1901. The photographic instruments used at the camp were driven by a simple method of gearing from a controlled motor, the method of control being designed by W. P. Gerrish, of Harvard College Observatory. The main driving motor is geared to a spindle intended to make one revolution a second, and this is provided with a commutator. In the motor circuit are brushes bearing on this commutator, and also the tapper of a relay. The relay is actuated by an adjustable pendulum with mercury contact and subsidiary battery, the closing of the relay allowing the main battery circuit to actuate the motor. It will be seen then that the motor can only be fed with current when the pendulum is swinging in unison with the revolving commutator. Although the motor is thus driven by a succession of impulses, it was found possible to maintain an exceedingly uniform motion of the driving screw, and the arrangement therefore appears to be of extreme utility for these expeditions in regions away from fixed observatories. C. P. B.

1824. *Total Solar Eclipse, May* 17–18, 1901. **H. W. Smith.** (Astrophys. Journ. 15. pp. 199–207, April, 1902.)—In this paper the author gives a preliminary account of the photographic work undertaken by the expedition from the Massachusetts Institute of Technology to Sawah Loento, in Sumatra. Four lenses were employed for obtaining pictures of the corona and of the surrounding regions of the sky in search of intra-mercurial planets. One of the corona cameras was provided with isochromatic plates and a colour-screen. All four cameras were mounted on a wooden framework rigidly attached to a steel polar axis, which was driven by an electric motor ingeniously controlled from a pendulum adjustable for rate. [See preceding Abstract.] A portable storage battery of six *five-ampere* cells was found sufficient to drive the motor. Several of the plates were spoilt by the clouds, but two excellent negatives were obtained, one exposed for half a second and showing the prominences at second contact, the other a long exposure of 20 seconds for coronal extensions. The coronal disturbance described by other observers is well shown on both negatives. The polar streamers extend nearly one-half diameter from the moon's limb, and the equatorial streamers on the west fully one diameter. A noticeable feature was that, notwithstanding the long duration of totality, the darkness was never such as to render a lamp necessary. Attempts were made to photograph the shadow bands directly, but their ill-defined appearance was sufficient to explain the negative results. C. P. B.

1825. *Stellar Scintillation.* **E. von Oppolzer.** (Akad. Wiss. Wien, Sitz. Ber. 110. 2a. pp. 1239–1252, Dec., 1901.)—The author considers

Montigny's problem, to determine the separation of two rays of different refrangibilities, both coming from the same star, and both arriving at the same point. He sets out from the formula for a medium composed of homogeneous spherical shells, $\mu r \sin i = \text{constant} = \mu_0 a \sin z$; here μ is the index of refraction at distance r from the earth's centre, i the inclination of the ray to the radius r, μ_0 the index at the earth's surface, a the earth's radius, and z the apparent zenith distance of the ray. For the linear separation at the limit of the atmosphere of two rays whose indices of refraction differ at the earth's surface by $\delta\mu_0$ he finds—

$$\Sigma = a\,\delta\mu_0 \,.\, \sin z \left\{1 - R_0\mu_0 \cot z/(\mu_0 - 1)\right\},$$

R_0 denoting the "refraction" at the place of observation (defined by $z = z_0 - R_0$, where z_0 is the true zenith distance. This result differs both from that of Montigny and that of Rayleigh (Phil. Mag. 5. 36. p. 129). It applies only to rays meeting at sea-level; the requisite modifications for other cases are given. W. S.

1826. *Brightness of Star-Clusters.* **J. Holetschek.** (Akad. Wiss. Wien, Sitz. Ber. 110. 2a. pp. 1253–1297, Dec., 1901.)—The author compares the observed brightness of a large number of clusters with that calculated from the brightnesses of the individual stars. He finds that the brightness of the cluster is given, to a very close degree of approximation, by that calculated from a comparatively small number of the brighter stars; generally it is sufficient to take the stars of the two lowest magnitudes in the cluster. A large number of numerical instances are given. W. S.

1827. *Analytical Discussion of Algol Variables.* **A. W. Roberts.** (Roy. Soc. Edinburgh, Proc. 24. pp. 71–84, May, 1902.)—An examination is made of the general principles of Algol variation, in which the character, extent, and duration of the mutual eclipses in any dual stellar system depend on the elements of the orbit, and on the relative size and brightness of the component stars. The latter being known, we can calculate what the amount of eclipse will be, but in general practice the problem is the converse of this, the elements of the orbit having to be determined from the observed light curve. After deriving the formulæ necessary, they are applied to the variable of this type recently discovered at the Cape Observatory—C.P.D. — 41·4511°. The period is 44h. 30m., and the variation in brightness is confined to 4h. 30m. The orbit of the system is inclined 5° 43′ to the plane of sight; both components are about equal in size but not in brightness, one being about six times as bright as the other. The two stars are separated from one another by a distance equal to twice the diameter of either. The mean density of the system is about half that of the sun, or two-thirds that of water. C. P. B.

REFERENCES.

1828. *Gravity Measurement.* **L. Haasemann.** (Zeitschr. Instrumentenk. 22. pp. 97–103, April, 1902.)—This is a description, with discussion, of pendulum apparatus, with chronometer, for the German South Polar Expedition. A. D.

1829. *Maximum Moments and Wheel Loads.* (Railroad Gazette, 34. pp. 373–374, May 23, 1902.)—Several problems on beams with a distributed dead load and a system of concentrated travelling loads are worked out. H. R. C.

LIGHT.

1830. *Reflection and Transmission of Light by Metal Conducting a Current.* **P. V. Bevan.** (Cambridge Phil. Soc., Proc. 11. pp. 380–390, May, 1902.)—The effect of the current in the metal is to cause an alteration in the constants of the metal, but this alteration is too small for the effects to be measurable (taking 10^{-2} of a wave-length as the minimum change of phase which can be detected.) The alteration also of the plane of polarisation (or rather of the major axis of the ellipse of polarisation) of reflected light is similarly too small to be detected. The thickness of metal through which light can be passed being only a few wave-lengths, there is no possibility of the small difference of velocity producing a large enough change of phase to admit of measurement. A. D.

1831. *Index of Refraction of Liquid Mixtures.* **E. van Aubel.** (Comptes Rendus, 134. pp. 985–987, April 28, 1902.)—A. Leduc finds [see Abstract No. 1510 (1902)] that the refractive energy of the components is conserved in the mixture of two liquids; and verifies this in a mixture of alcohol and water which presents the maximum index of refraction. The law is, however, by no means a general one; the refractive energy is generally not conserved. A. D.

1832. *Indices of Refraction of Solutions of Sodium Chloride.* **C. Bender.** (Ann. d. Physik, 8. 1. pp. 109–122, April 29, 1902.)—Values are given of the indices of refraction of sodium chloride solution of the following strengths: N/5 N, 2N, 3N, 4N and 4·5N for the rays H_α, D, H_β and H_γ. The methods of experiment have already been described [see Abstract No. 1413 (1900)] and the temperature limits were 10° to 70°. From the values given, the following numbers were calculated, the light being that of the D line: Molecular refraction of NaCl at 15°, 9·273; Index of refraction of solid NaCl at 15°, 1·5985; Atomic refraction of sodium at 15°, 3·493; Index of refraction of metallic sodium at 15°, 1·23601. E. C. C. B.

1833. *The Observation of Conical Refraction.* **C. Raveau.** (Soc. Franc. Phys., Séances, 3. pp. 226–229, 1901.)—It is usual in discussing the singularities of Fresnel's wave-surface to consider only such geometrical abstractions as single rays and ray-cones. The author endeavours to extend the theory to the study of small pencils, with which we are always concerned in practice. Suppose a small incident pencil of rays in the region of the optic axis to converge to a point S on the face of a doubly refracting crystal plate with parallel faces. A certain ray, AS of this pencil, will on entering the crystal be divided, not into two rays, but into a cone of rays, and the emergent beam will be a cylinder of the second degree C. Further, every ray lying on a certain cone of the incident pencil will have one of its emerging components on a cone Γ, whose vertex is on the second face of the crystal and inside C. The other rays of the incident pencil, supposed to have the form of a cone about AS, will emerge around the cylinder C, and may then be regarded as making up a system of elementary pencils, each having for axis a generator of C. One focus of such a pencil is at infinity, where the generator meets its neighbour. In finding the other focus, the emergent rays are considered as lying in planes normal to the cylinder along a generator, the focus being the point where a generator meets a ray lying in such a plane. The two rays due to the doubling of any incident ray IS lie in the two normal planes of the cylinder parallel to SAI. It is to be noted that the two caustic-surfaces for the ordinary and extraordinary pencils merge into one in the region under discussion, where we pass continuously from one sheet of the wave-surface to the other. The caustic is a surface of two sheets, and, in view of the small inclination between the generators of the cone and cylinder, one sheet must be tangential to Γ and C near one of their curves of intersection. Further consideration shows that the required focus lies near the curve of intersection of C with the sheet of the cone opening towards the point S. In the usual arrangement for showing the existence of conical refraction, an illuminated hole is projected across a crystal plate by means of a lens, and a bright ring is obtained on a screen, which is the image of the curve of contact of C with the caustic. On widening the illuminating pencil, the ring will be found to gain in brightness without losing much in sharpness. The second sheet of the caustic has a singular form, it is asymptotic to C, and has a conical point at the vertex of Γ. Except at infinity, it reduces sensibly to a line. A corresponding white spot may be found by shifting the screen, and serves to show when the plate is properly oriented. The spot disappears in the region of the focal plane of the projecting lens. A. E.

1834. *Focus of an Oblique Pencil refracted at a Spherical Surface. A Simple Proof of Young's Formula.* **A. Champigny.** (Soc. Franc. Phys., Séances, 3. pp. 220–222, 1901.)—Let A be the source, B the (primary) focus, C the centre of curvature, O the point of incidence, AO $= a$, BO $= b$, angle OCA $= 0$, and angle OAC $= \alpha$. Then $i = o + \alpha$ and $d\alpha = di - do$, also $di \cos i = ndr \cos r$. If O′ be a point near O, we have from the triangle AOO′, AO′ : sin O :: OO′ : sin $d\alpha$, or $a/\cos i = \rho do/d\alpha = \rho do/(di - do)$, or $do(\rho \cos i + a) = adi$. Similarly from the triangle BOO′, $do(\rho \cos r + b) = bdr$, and by division—

$$\frac{\rho \cos i + a}{\rho \cos r + b} = \frac{n \cos r}{\cos i} \cdot \frac{a}{b}.$$

A. E.

1835. *Images of a Point by Refraction at a Spherical Surface.* **A. Cornu.** (Soc. Franc. Phys., Séances, 3. pp. 222–226, 1901.)—The construction for the focus of a pencil of rays in the plane of incidence depends on the following theorem [stated by Young (see Phil. Trans. 1801, xcii. p. 28), but rediscovered by Cornu]: Let A be a luminous point in the plane of a refracting curve OM; AO, OB an incident and refracted ray, B the point on the caustic corresponding to A. Then as A moves along the incident ray, the line AB always passes through a fixed point J. The point J, called the centre of junction, is the foot of the perpendicular let fall from C the centre of curvature at O, upon the line joining the feet of the perpendiculars from C on AO, OB. The theorem follows at once from the well-known formula $(\cos i - n \cos r)/\rho = \cos^2 i/a - n \cos^2 r/b$, where $a =$ OA, $b =$ OB, and ρ is the radius of curvature. For the equation of the line AB referred to oblique axes OA′, OB will be $x/a + y/b = 1$, and since the above formula expresses a linear relation between the reciprocals of a and b, the line passes through a fixed point. The co-ordinates of this point, $x = -\rho \sin r \cos^2 i/\sin(i = r)$; $y = +\rho \sin i, \cos^2 r/\sin(i - r)$, will be found to satisfy the conditions stated above. The image of the point A is, of course, astigmatic, being composed of two linear elements. One element (primary focus) is perpendicular to the plane of incidence at B, the other (secondary focus) lies in the plane of incidence along AC, where AC cuts the refracted rays. Thus for the secondary focus, C takes the place of J. A. E.

1836. *Improved Michelson Interferometer.* **H. C. Pocklington.** (Cambridge Phil. Soc., Proc. 11. pp. 375–379, May, 1902.)—In the modified arrangement, the two interfering beams consist of circularly polarised light, and a retardation of either causes rotation of plane of polarisation of the resultant. The incident light employed is plane polarised. A plate of mica producing a retardation of ⅛ wave is inserted in the path of one beam, and a similar plate in the path of the other beam. As each plate is traversed both in going and returning, each beam has ¼ wave retardation of one of its two component vibrations compared with the other, and is thus circularly polarised. The polarisations of the two beams are opposite, and the resulting plane polarised beam is examined by a nicol. When the nicol is rotated, the interference bands move across the field. It is claimed that the accuracy of an observation is nearly two hundredfold greater than in the ordinary method. An alternative method, suggested by Laurent's Polaristrobometer, and not involving the use of circularly polarised light, is described in a Note of later date. The mirrors are to be adjusted so as to give an even shade; and then half of one mirror is to be covered with a thin plate which causes a small retardation (or a plate may be cut in two and one half slightly tilted). If now the whole of the light be retarded by a further accurately measurable amount (by interposing a moderately thin plate which can be inclined), the two halves of the field will become dark in rapid succession as the analyser is rotated. A very small rotation of the analyser has a large effect, giving great sensitiveness. A. E.

1837. *Focal Lines and Anchor-ring Wave-fronts.* **J. D. Everett.** (Phil. Mag. 3. pp. 483–486, May, 1902. Paper read before the Physical Society.)—The case here described is that in which the wave-front in one of its positions is a tore or anchor-ring. All the rays, even of a large pencil, incident obliquely on a spherical reflecting or refracting surface, in this case pass through two definite focal lines. Of these, one is a circular arc cutting the pencil at right angles, and the other is a straight line, which may have any inclination to the axis of the pencil. This is shown mathematically, and experimental illustrations are given. J. W. P.

1838. *Negative Images due to Certain Vapours.* **P. Vignon.** (Comptes Rendus, 134. pp. 902–904, April 21, 1902.)—Colson and Russell have investigated the emanations from a fresh surface of zinc, capable of fogging a photographic plate or making an image of scratches on the zinc. The author has made negatives of medallions in plaster dusted with powdered zinc, and so forth; the reliefs make more impression than the hollows, being nearer to the plate. The scale of relief is very well brought out, but the hollows are blurred, not being in contact: the contrasts are increased. Ammoniacal vapour acting upon linen impregnated with a mixture of powdered aloes and olive oil also makes brown negative images. A. D.

1839. *Stereoscopic Radiography.* **T. Guilloz.** (Comptes Rendus, 134. pp. 756–758, April 1, 1902.)—Images are formed in rapid alternation, one for each eye, by means of apparatus which is described, while the other eye is masked off. If the frequency of alternation be sufficient, the impression on each eye is continuous, and the combined effect is that of stereoscopic relief. A. D.

1840. *The Retina.* **C. Maltézos.** (Journ. de Physique, 1. pp. 228–233, April, 1902.)—The eye fatigued by light, comes sooner to its normal state when directed towards green colour of moderate luminosity. This is not easy to explain on Young's, but is readily explained on Hering's theory. The minimum visible luminosity, which is smaller as we go towards the periphery from the *fovea centralis,* seems to undergo an oscillation in its value. In darkness, the result of concentrated attention (central action in the optic nerve) is an irregular very feeble stimulation, particularly in the region of cones. Concentrated attention, upon a bright light looked at, much reduces the after-effects of fatigue: there may even be no after-image at all, while the same flame casually in view but not looked at may induce a powerful after-image. The cerebral activity thus increases the restitutive power of the optic nerve (the absence of attention thus explaining amblyopia by anopsis, the blindness of an unused eye). Light falling on the retina induces—(1) bleaching of the retina-purple (which is regenerated in darkness); (2) transport of pigment from the pigmentary cells so as to construct the section of the rods and cones; (3) swelling of the ends of the rods and cones; (4) probably, torsions of the rods and cones. The rods and cones have to send back the pigmentary matter brought between them during the action of light; if they fail to do this we have the pigmentary degeneration of the retina. The pigmentary epithelium seems therefore to act as a kind of brake put upon the too energetic movements of the rods and cones; but the case of albinos shows that it is not indispensable to vision. A. D.

1841. *Zeeman Effect on Series Lines.* **C. Runge and F. Paschen.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 19. pp. 380–386, April 10, 1902. Also Astrophys. Journ. 15. pp. 333–339, June, 1902.)—Preston observed that lines of different elements, which correspond to one another according to the series law, are decomposed in the magnetic field in such a way that on a scale of vibration numbers the components of corresponding lines in equal magnetic fields stand at equal distances. The authors have verified this with great care for Hg, Mg, Zn, Cd, Sr. When the lines are normal triplets it follows from H. A. Lorentz's laws, that in the spectra of the different elements the relation of the charge to the mass of each particle is the same: and it would seem as if in the different spectra we had to do with identical particles with an intermolecular material corresponding to the respective elements. In the spectra of different elements similar charged particles oscillate round their centres of gravity while the chemical molecules only determine the forces with which the particles are, in the absence of a magnetic field, drawn into the position of equilibrium. The spectrum is therefore different for each element; but the decomposition of corresponding lines in a magnetic field is equal in different spectra. A. D.

1842. *Magnetic Rotation of the Polarisation Plane in an Absorption Band.* **P. Zeeman.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 6–12, May 31, 1902.—A result of Voigt's theory relative to the rotation of the polarisation plane in an absorption band seemed to be contradicted by Corbino's recent researches [see Abstract No. 36 (1902)]; in fact, instead of a negative rotation in the interior of an absorption band, as required by this theory, he obtained a small positive rotation only. The author therefore tests this question by new experiments, observing the alterations shown by the interference bands produced by a Fresnel prism system in the neighbourhood of the sodium lines, as the amount of sodium vapour present in the magnetic field is gradually increased, the latter being kept constant. In a field of 18,000 units, a displacement equivalent to more than twice the distance of two bands, corresponding to a negative rotation of approximately 400° was observed in the case of D_1, the distance of the poles being 4 mm. With D_2 the phenomena noted were of a similar character. Increasing the magnetic field will produce a diminution of this negative rotation. For very high vapour densities, however, phenomena identical with those recorded by Corbino were noted. The author maintains that this behaviour is not in disagreement with the theory; further experimental work, however, will be necessary to account for the whole of the phenomena observed. A. G.

1843. *Rotatory Magnetic Dispersion within Absorption Lines.* **W. Voigt.** (Accad. Lincei, Atti, 11. pp. 459–462, May 31, 1902.)—Corbino's results [see Abstracts Nos. 36, 1515 (1902): Voigt, Abstract No. 465 (1902)] do not involve any contradiction between theory and observation. They only show that certain complications were present, which have been dealt with by Zeeman (see preceding Abstract). A. D.

1844. *Magneto-Optics.* **Q. Majorana.** (Accad. Lincei, Atti, 11. pp. 374–376, May 4, 1902.)—On the analogy of Kerr's discovery (electrostatic lines of force inducing a certain anisotropism of a uniform medium, and therefore inducing birefringent power), the author sought for birefringence as the result of magnetic lines of force in a mobile magnetic medium. He found this to a slight extent in a solution of ferric chloride, and notably in some kinds of dialysed iron and ferric oxide in colloid solution; so that these converted plane into circularly polarised light. This birefringence could be compensated by glass subject to strain. Further, in solutions of ferric chloride which had been shaken up with oxide of iron, there is a rotation of the plane of polarisation when this plane was not parallel or normal to the lines of force, which rotation is independent of the direction of the field ("bimagnetic rotation") and is possibly due to the magnetic properties of the medium itself. Both these rotations are positive or negative according to the sample of liquid used; and the inquiry is complicated by the coexistence of more than one of these phenomena. A. D.

1845. *Action of Self-induction on the Spectra of Dissociation of Compounds.* **A. de Gramont.** (Comptes Rendus, 134. pp. 1048–1050, May 5, and pp. 1205–1207, May 26, 1902.)—The author describes experiments in which he has applied the results of Schuster and Hemsalech on the effect of self-induction in the sparking circuit upon the spectra of metals, to the analysis of the spectra of minerals and metallurgical products. [See Abstract No. 1066 (1900).] The introduction of self-induction into the circuit, weak at first and gradually increasing, procures simplification of the spectra of dissociation, by eliminating first the air spectrum, then successively those of different metalloids: this may be advantageous in researches in analytical chemistry. His results confirm the conclusions of Hemsalech and the classification of rays founded by that experimenter on his study of the metals. W. C. H.

1846. *Lamps for Spectroscopic Analysis. IV.* **E. Beckmann.** (Zeitschr. Phys. Chem. 40. pp. 465–474, April 15, 1902. Communicated by the Laboratory for Applied Chemistry in the University of Leipzig.)—This is a continuation of papers already published by the author. [See Abstracts Nos. 2419 (1900) and 1491 (1901).] He here gives methods by which solutions may be converted into spray for spectroscopic purposes, and describes a modification of the glass apparatus used by Ebert and others. This modification consists in constructing the nozzle of ebonite, and allows the apparatus to be more accurately made and adjusted. A rod of ebonite has a passage made through a portion of its length, connecting by a lateral opening with the fluid to be sprayed. Another passage introduces air under pressure, the two passages terminating immediately beneath an ebonite cap or nozzle. A further method of spraying solutions is a modification of the device originally described by Lockyer. Air under pressure is led over the top of a tube connected to a vessel containing the liquid, the whole being contained in a cylindrical glass chamber, which has a tube connected to it on the top side. In this way the air charged with liquid particles in a fine state of division escapes by the top tube. This method is considered to be the most suitable for ordinary chemical work. W. H. S.

1847. *Spectrum Arrangement for Microphotometer.* **J. Koenigsberger.** (Zeitschr. Instrumentenk. 22. pp. 88–89, March, 1902.)—In a previous paper [see Abstract No. 1631 (1901)] the author described a microphotometer, and now suggests a small addition for spectrophotometric purposes. This consists simply in the insertion of a tube, containing a small direct-vision prism, between the analysor and the telescope; by reflection from the face of the prism the image of a scale in a side tube is thrown into the telescope so that the observer can see both the spectrum and the scale. For greater dispersion a second tube, containing two achromatic lenses placed the sum of their focal lengths apart, can be placed between the analysor and prism. Increased brightness and considerable accuracy is claimed for the apparatus.
E. C. C. B.

1848. *Arc Spectra in Nitrogen, Hydrogen, and Ammonia.* **R. A. Porter.** (Astrophys. Journ. 15. pp. 274–281, May, 1902.)—Photographs were taken of the spectra of the arc in atmospheres of hydrogen, nitrogen, and ammonia, with iron, zinc, magnesium, and tin electrodes, and it was found that the effect of ammonia was approximately the sum of the effects of hydrogen and nitrogen as regards change of average intensity of the lines. Hydrogen reduces the average intensity very strikingly. Also, as a general rule, the spark lines are relatively reduced by nitrogen and enhanced by hydrogen. [Many of these facts, especially in connection with hydrogen, have been noted by Basquin.] [See Abstract No. 677 (1902).] E. C. C. B.

1849. *Ultraviolet Mercury Spectrum.* **H. Lehmann** and **R. Straubel.** (Ann. d. Physik, 7. 4. pp. 909–911, April 8, 1902.)—The authors give a series of 27 lines in the ultraviolet region of the mercury spectrum between $\lambda = 2213$ and $\lambda = 1930$. The wave-lengths were obtained by comparison with the aluminium spark spectrum and two lines of Eden and Valenta's mercury spectrum. Kayser and Runge's formula does not apply to these lines below the limit of $\lambda = 2150$. This is, however, in accord with Schumann's observations of the ultraviolet spectrum of other elements. E. C. C. B.

1850. *Ultraviolet Spark Spectra of Elements.* **F. Exner** and **E. Haschek.** (Akad. Wiss. Wien, Sitz. Ber. 110. 2a. pp. 964–987, 1901.)—This paper, which completes the list of the elementary ultraviolet spark spectra, contains those of thorium, arsenic, oxygen, nitrogen, chlorine, radium, and polonium, and in addition to these, the following elements were found in no way to give a spark spectrum at atmospheric pressure: selenium, sulphur, phosphorus, bromine, and iodine. Hydrogen and fluorine were also experimented upon, but the well-known broadening of the lines, in the case of the former, prevented any measurements being taken, and, in the case of fluorine, only a faint continuous spectrum was seen, with curious bright maxima. The wave-lengths of the lines are given at length, but there is much doubt about the lines attributed to polonium. The paper concludes with a lengthy discussion on the probable accuracy of the whole research, which is very high, and also contains an interesting diagram showing the relation between the number of spark spectrum lines given by the elements and their atomic weights. A curve is drawn showing periodical maxima and minima with a general tendency to increase with the higher atomic weights. [See also Abstract No. 676 (1902).]

E. C. C. B.

1851. *Ultraviolet Absorption of Solid Cyanine.* **A. Pflüger.** (Ann. d. Physik, 8. 1. pp. 230–232, April 29, 1902.)—In previous papers the author has noticed an absorption band in the ultraviolet region of the cyanine spectrum which is less intense than the one in the green. Wood, however, found this ultraviolet band to be very intense [see Abstract No. 2345 (1901)] which the author says was due to the use of common cyanine. A repetition of his old experiments confirms the author's original opinion. [See Abstract No. 1211 (1898).]

E. C. C. B.

1852. *Action of Light on Precious Stones.* **Chaumet.** (Comptes Rendus, 134. pp. 1139–1140, May 20, 1902.)—The fluorescence excited in the diamond by violet light is well known. The author finds that this is intimately related to the brilliancy displayed by the diamond in artificial light, especially candlelight. The most brilliant stones are not the most regularly cut, but those which are most clearly fluorescent when subjected to violet light; they exhibit a clear blue, very luminous fluorescence, while less brilliant diamonds simply assume a violet colour. A brilliant yellow diamond with a large number of facets, when subjected to the action of violet light for a few minutes, shone vivid red, and its colour afterwards had changed from yellow to dull brown, the stone thereby losing four-fifths of its commercial value; it recovered its colour and brilliancy in twenty-four hours. The action of violet light also distinguishes the rubies of Siam from the greatly inferior rubies of Burmah. Those of Siam exhibit a scarcely appreciable fluorescence, while the Burmese stones are invariably very fluorescent and gleam brilliant red.

W. S.

1853. *Radio-activity of Thorium.* **E. Rutherford** and **F. Soddy.** (Chem. Soc., Journ. 81. and 82. pp. 321–350, April, and pp. 837–860, July, 1902.)—After an historical *résumé* of present knowledge as to radio-activity, the authors state the scope of their own work, which has for its object the investigation of the radio-active emanation from thorium, though incidentally the ordinary emanation is also examined. The methods employed are electrical, and depend on the fact that the radiation in question possesses the power of discharging both positive and negative electricity. These methods are capable of great refinement and certainty. The questions proposed for answer by the experiments undertaken are the following:—1. Is the power of producing an emanation a specific property of thorium, or is it due to a foreign substance which may be capable of separation from the thorium by chemical means? 2. Can the emanating power of "de-emanated" thoria be regenerated by chemical means? 3. Does the emanation or radio-active gas itself possess any property which would associate it chemically with any known kind of gravitational matter? 4. Is it possible to detect by means of the balance any loss of weight corresponding to the continuous emission of the emanation, or any gain in weight of bodies rendered radio-active thereby? 5. Does the chemistry of thorium present any peculiarity capable of being connected with its almost unique power of producing an emanation? The present paper deals with the answers so far obtained to the first three questions. The emanating power and radio-activity were measured by observing the conducting power imparted to air as tested by a Kelvin quadrant electrometer of the White pattern. The rate of decay of the radiation from the emanation was observed. Thoria loses its emanating power to a large extent on intense ignition, but regains its power after a time. The cause of the emanating power appears to be only rendered inoperative for a period by ignition. Suggestions as to the nature of the emanation are considered. One of the inert constituents of the atmosphere may be rendered radio-active in the presence of thorium, or thorium compounds may emit a gas which constitutes the emanation. The latest experiments described give an account of the separation of thorium compounds into two portions, one possessing radio-active power in but a slight degree, the other possessing radio-active power in a degree many hundred times greater than that of ordinary thorium compounds. Substances chemically free from thorium have also been prepared possessing thorium radio-activity in an intense degree. It seems probable that, so far, the active constituent of thorium has only been obtained in relatively minute quantity, and therefore does not answer to any definite analytical reactions. J. J. S.

1854. *Absorption of Radio-activity by Liquids.* **T. Tommasina.** (Comptes Rendus, 134. pp. 900–902, April 21, 1902.)—The author describes his arrangement for studying the absorption of radio-activity by alcohol, benzene, petroleum, ammonia, glycerine, water, &c. A Curie electroscope is used, and the effect of the radiation from radium and barium chlorides, passing through layers of different thicknesses of the liquids is studied. A table of figures is given, showing the magnitude of the absorption for the different liquids. J. W. P.

1855. *Bactericidal Action of Light from Rapid-Oscillation High-tension Arc.* **H. Walsham.** (Röntgen Ray, Archives, 6. pp. 85–89, April, 1902.)—The bactericidal effects of the arc light are much superior to those of sunlight; the very rapid ultraviolet is absorbed by the atmosphere. A rapid oscillation high-tension arc, particularly between iron points, gives off an abundance of ultraviolet rays of extremely small wave-length, with a fair proportion of lower refrangibility; to these ultraviolet rays quartz is transparent, transmitting 60 per cent. through 4·4 mm., gelatine is quite opaque, ice is as transparent as air, and a film of iron oxide quite opaque. For use, as blood is opaque to the rays, they are passed through ice made to press upon the region affected, so as to make it anæmic. A. D.

REFERENCE.

1856. *Optical Measurements of Thickness.* **J. M. de Lépinay.** (Comptes Rendus, 134. pp. 898–900, April 21, 1902.)—A differential fringe method is described, which obviates the necessity of knowing the refractive index of the lamina to be measured. Practical description and results are to be communicated later. A. D.

HEAT.

1857. *Density and Expansibility of Ice.* **J. H. Vincent.** (Roy. Soc., Phil. Trans. 198. pp. 463–481, May 13, 1902. Roy. Soc., Proc. 69. pp. 422–424, March 21, 1902 (Abstract).)—The water or ice under experiment was caught below an umbrella-shaped vessel of steel immersed in mercury and attached to a scale-pan by a vertical steel wire passing through a small hole in the bottom of the funnel containing the mercury, so that its buoyancy could be equilibrated and thus measured. Ten measurements were made on four specimens of water at temperatures ranging from —10·02° to —0·37°. They seem to show that, as Nichols suggests, the same specimen of water may assume different densities on freezing, seven observations giving 0·916212 as an average for the density of ice at 0°, while three give 0·915487. The author concludes that 0·9160 may be taken as the density of ice at 0°, and that its cubical expansibility is 0·000152; he further thinks that the use of Bunsen's ice calorimeter is limited in accuracy to $\frac{1}{10}$ per cent. owing to possible differences in the character of the ice that results from the freezing of water. A useful and comprehensive *résumé* of the work done by previous observers is given. R. E. B.

1858. *Heat of Solidification of Liquid Ammonia.* **de Forcrand** and **G. Massol.** (Comptes Rendus, 134. pp. 743–745, April 1, 1902.)—If the heat of solution at 10° of liquid NH_3 taken at —77° be calculated (1) from the specific heat of liquid NH_3, its heat of volatilisation at —32·5°, the specific heat of NH_3 gas, and the heat of solution of NH_3 gas at 10°; (2) from the specific heat of the liquid, and its heat of volatilisation at 10°, the values of 2·02 cal. and 1,855 cal. are respectively obtained, in agreement with the value + 1·77 cal. previously found. [See Abstract No. 1328 (1902).] If the mean of the three results be added to the heat of solution of solid NH_3 at — 77° in water at 10° + 1·95 cal. is again obtained for the heat of solidification of 17 gr. of liquid NH_3 at — 77°. The similarities between the properties of water and NH_3 are pointed out, and conformably to theory the difference (3·92 cal.) between their molecular heats of volatilisation at their boiling-points, and the difference (132·5°) between their boiling-points are such as to satisfy the equation $3920/132·5 = 30$. W. E. T.

1859. *Latent Heat of Ammonia.* **de Forcrand.** (Comptes Rendus, 134. pp. 768–770, April 7, 1902.)—The author obtains a confirmation of the value + 7·695 cal., previously obtained for L + S for NH_3 [see Abstract No. 1327 (1902)], by the direct determination of the values of L and S. S has been determined as equal to + 1·95 cal. (see preceding Abstract), and by the application of Clapeyron's calculation to Regnault's determinations of the vapour pressure of liquid NH_3, L is now found to be + 5·73 cal.

W. E. T.

1860. *Verification of Kirchhoff's Law for the Emission and Absorption of Glowing Tourmaline.* **A. Pflüger.** (Ann d. Physik, 7. 4. pp. 806–817, April 8, 1902.)—The only experimenters who have hitherto verified this law directly are Bouman (who used heated glass and a radiomicrometer) and Rosenthal (who used heated quartz and mica and a spectrobolometric method). The author uses plates of green tourmaline cut parallel to the axis and about 5 mm. thick. Then if I be the intensity of the source of light, T that of the transmitted, and R that of the reflected light, A the absorbed intensity, we have $A = I(1 - R - T)$. Then if Kirchhoff's law hold we must have (using the suffixes *e* and *o* to denote the extraordinary and ordinary rays) for the same temperature and wave-length $E_e/A_e = E_o/A_o$, or $E_e/E_o = A_e/A_o$, where E_e, E_o denote the components of the intensity emitted by the plate. The author measures E_e, E_o, T_e, T_o by a Lummer-Brodhun spectrophotometer, provided of course with a polarisation arrangement. R_e and R_o are calculated from the indices of refraction of the crystal. I_e and I_o are obtained by the spectrophotometer. The tourmaline is heated in a fishtail Bunsen flame. The source of light is a slit illuminated by an incandescent lamp. A lens casts a real image of the slit on the surface of the tourmaline plate, which can be adjusted to any required position. A real image of the first image and of the tourmaline plate is formed by a second lens in the plane of the collimator slit of the photometer. The Bunsen gives no radiation in the region used. The author shows that all assumptions and approximations used are justified. The results are given in the following table:—

No. of Experiment.	No. of Tourmaline Plate.	λ in μμ.	$\frac{A_e}{A_o}$(cold).	$\frac{A_e}{A_o}$	$\frac{E_e}{E_o}$	Percentage Difference.
1	1	635	—	0·580	0·578	0·04
2	2	635	0·470	0·650	0·641	1·2
3	2	610	—	0·488	0·492	0·8
4	3	635	0·375	0·600	0·589	1·8
5	3	610	—	0·439	0·438	0·02
6	3	635	—	0·590	0·594	0·7

W. S.

REFERENCES.

1861. *Specific Heat of Solutions, III.* **W. F. Magie.** (Phys. Rev. 14. pp. 193–203, April, 1902.)—This is in continuation of a former paper [see Abstract No. 2125 (1901)], and describes in detail the author's improved apparatus [see Abstract No. 76 (1900)] and his method of observation and correction. R. E. B.

1862. *Mutual Inter-distribution of the Elements of Two Swarms according to the Law of Chance.* **M. Thiesen.** (Deutsch. Phys. Gesell., Verh. 4. 6. pp. 98–105, March 21, 1902.)—The author holds Boltzmann's analysis to be bad, and gives his own solution of the problem, in which the non-continuity of the elements is especially considered. The Maxwell law then follows only on particular assumptions being made. R. E. B.

1863. *Self-regulating Thermostat.* **Tedeschi-Rosselli.** (Elettricità, Milan, 21. pp. 290–293, May 11, 1902.)—Descriptions are given, with drawings, of the Tedeschi-Rosselli self-regulating electric thermostat for bacteriological, embryological, and other purposes. A. D.

SOUND.

1864. *The Vowel "a."* **L. Bevier, Jr.** (Phys. Rev. 14. pp. 171–180, March, and pp. 214–220, April, 1902.)—In a former article [see Abstract No. 1451 (1900)] the author published his results on the analysis of the vowel *a* (as in father). He now considers the vowel *a* (as in hat). The method is to obtain the curve from a phonograph, then to measure ordinates and abscissæ (this by a microscope) and so analyse, using the Fourier series, looking for harmonics up to the tenth. In the case of the more simple curves, the eye can analyse the curve without mathematical aid. Results show that there are three resonance regions near frequencies 1550, 1050, 650, the first being by far the most important one. To explain, suppose the fundamental is 202, or 226, the reinforced harmonic will be 1616 or 1582 respectively. Whatever fundamental be sounded, the mouth cavity resonates the nearest harmonic to 1550. The same applies in less degree to the other resonance regions. But for very low fundamentals, it is obvious that the harmonics lie close together, hence the mouth, being, not hard, but a soft, flabby resonator, responds to and amplifies more than one harmonic (sometimes even three) in the region of resonance.

In the second part of the paper the author gives the analysis of the sound *e* (in pet). The method adopted is identical with that given in Abstract No 1451 (1900), on the sound *a* (in father). In this case the strongest resonance is for frequency 1,800. There are two centres of weaker resonance at 1,050 and 620. Tables and curves are given. P. E. S.

1865. *Flutings in Sound-waves.* **S. R. Cook.** (Phil. Mag. 3. pp. 471–482, May, 1902. Paper read before the Denver meeting of the American Association for the Advancement of Science.)—The question of the explanation of acoustic attractions and repulsions by hydrodynamical considerations is here dealt with. Koenig supposed the perfect fluid to supply adequate explanation, but here the idea of viscosity is introduced. The perfect fluid contains forces which are essential, but not sufficient, to produce the flutings, and by experiment it is found that there are other forces both parallel and perpendicular to the stream lines. These additional forces are due to the viscosity of the medium. The ease with which flutings may be formed depends upon the size, shape, and specific gravity of the fluting material, and upon the molecular weight, density, and viscosity of the medium. Experiments (modified forms of the Kundt sound apparatus) are described with a variety of fluting materials (magnesium carbonate, lycopodium, cork dust, brass and iron filings, &c.), and with air, carbon-dioxide and chlorine as media. Small spheres of sealing-wax of very perfect form were also used in the Kundt tube, and their attractions and repulsions in the vibrating gas were studied microscopically. [See also Abstracts No. 2198 (1900) and 1094 (1901).]
J. W. P.

1866. *Interference of Sound.* **Rayleigh.** (Nature, 66. pp. 42–44, May 8, 1902. Royal Institution Discourse, Friday, Jan. 17, 1902.)—Experiments are described in which a "bird-call" was used as the source, and a high-pressure sensitive flame as the recipient. The construction of a suitable bird-call for laboratory and lecture experiments is described. The wave-lengths employed range from 1 to 3 cm., and thus many optical phenomena can be imitated. Experiments illustrating ordinary interference, Huyghens' zones, Lloyd's bands, Fresnel's bands, are described. Reference to fog signals and the use of elliptical horns is also made. [See Abstract No. 1337 (1902).] J. W. P.

ELECTRICITY AND MAGNETISM.

THEORY AND ELECTROSTATICS.

1867. *Motion of Ions in a Varying Magnetic Field.* **B. Davis.** (Science, 15. pp. 853–856, May 30, 1902.)—In some of the Crémieu experiments [see Abstracts Nos. 55, 56, and 482 (1902)] a disc was charged to a high potential, and suspended in the field of an electromagnet. When the current is broken, the disc should have experienced a force according to Maxwell's theory. The quantity of electricity that can be placed on a body of considerable dimensions is small, so that *e/m* is a small quantity. For a negative ion, this quantity is, however, very large, and therefore the ion should move with considerable velocity in a varying field of moderate strength. An anemometer possesses the property of rotating in one direction, whatever may be the direction of the particles acting on it. A special form of the instrument is placed at the centre of a large vessel which is surrounded by a large circular coil. An oscillatory discharge from a large battery of jars is sent through the coil, and, when the electrodeless discharge appears, a rotation is observed, sometimes in one direction and sometimes in another. Further experiments showed that some of these are due to radiometer effects, and after they are eliminated there still remains a definite rotation due to the motion of the ions. This is looked upon as definitely supporting Maxwell's theory. R. S. W.

1868. *Contact Difference of Potential.* **H. Pellat.** (International Physical Congress at Paris, Report, 4. pp. 77–83, 1900–1901.)—The author distinguishes between (1) the electromotive force of contact; (2) the true difference of potential; (3) the apparent difference of potential; (4) the difference of potential at contact according to Nernst's theory. (1) The quotient of the quantity of energy given to the current by the quantity of electricity which has passed, is determined from the Peltier effect in the case of two metals; (2) the quotient of the work done by the electric force acting on a charged particle passing from one place to the other by the quantity of electricity in the charge, has so far only been determined from electrocapillary phenomena; (3) is obtained from the study of condensers formed of the conductors in question; (4) is not to be *à priori* confounded with the true difference of potential. W. E. T.

1869. *E.M.F. due to Deformation of Electrodes.* **Hurmuzescu.** (Annal. Sci. de l'Univ. de Jassy, 2. pp. 63–64, April, 1902.)—Two electrodes, though of the same material, are rarely mechanically identical; the result is a small e.m.f. which may rise as high as some hundredths of a volt. If they be adjusted to reduce the electrometer to zero, traction upon one of the electrodes will make that electrode negative, and the more so the softer the metal is. Under magnetisation an electrode becomes more positive. It is as if traction laid the molecules more open to attack by acid, and magnetisation packed them closer together. A. D.

1870. *Electrostatic Rotations.* **G. Vicentini.** (N. Cimento, 3. pp. 296–306, April, 1902.)—References are given to Quincke (Wied. Ann. 59, 417, 1896), Heydweiller (Beibl. Wied. Ann. 21, 529, 1897), Boltzmann (W. A. 60, 399, 1897), Schweidler (Beibl. W. A. 22, 107, 1898), Heydweiller [see Abstract No. 102 (1900)]; Graetz [see Abstract No. 1280 (1900)]. The author has found rotations in liquid dielectrics; if quantities such as 3 litres be once set in rotation and a strong electric field set up between electrodes in the dielectric, the velocity of rotation is surprisingly accelerated. Various other movements are described; as a rule a maximum velocity is promptly obtained which gradually falls to a constant value, which depends upon the form of the electrodes. Exploration of the potentials in the rotating liquid. Analogous rotation in gases examined. A. D.

DISCHARGE AND OSCILLATIONS.

1871. *Self-Induction in Electric Discharges through Gases.* **B. Eginitis.** (Comptes Rendus, 134. pp. 1043–1046, May 5, 1902.)—The variation of the self-induction of the discharging circuit produces large variations in the heating effects at the poles between which the sparks pass. The temperature of the poles increases enormously, showing maxima and minima as the self-induction increases in value. This temperature depends also on the temperature of the poles before the sparks begin to pass. Experiments are described showing that an iron core inserted in an induction coil in the sparking circuit destroys the heating effect of self-induction. This destruction may be either total or partial, according to the value of the self-induction, the dimensions and nature of the core, and the nature, shape, and dimensions of the poles. As the self-induction increases, the distance between the poles remaining constant, the temperature of the poles at first increases very rapidly. The difference of temperature between the poles, almost zero at the commencement, becomes very large for small values of self-induction. The metals showing large heating effects—iron, nickel, cobalt—are metals whose spectra are intensified with increase of self-induction; those which do not show large variations in heating are metals whose spectra are more or less diminished in intensity, with increase of self-induction. The author does not agree with the opinion that the heating of the poles is due to the presence of metallic vapour, or yet to the disintegration of the poles. W. C. H.

1872. *Action of an Intense Magnetic Field on the Anode Column.* **H. Pellat.** (Comptes Rendus, 134. pp. 1046–1048, May 5, 1902.)—The author has already described the action of an intense magnetic field on the kathode stream, and has shown how this action may be explained [see Abstracts Nos. 823 and 1356 (1902)]. The present paper treats of the action upon the anode column. When the part of a Geissler tube which is well illuminated by anode rays is placed between the poles of an electromagnet, so that the magnetic lines of force are perpendicular to the rays, fields up to 425 c.g.s. units produce the well-known effect of deviation of the column and the formation of a luminous strip on the wall of the tube, becoming thinner and more intense as the field becomes stronger. But for field-strengths above 425 units, the luminous strip ceases to become thinner and increases more and more as the field increases, and for strengths of 7,000 to 8,000 units the anode column once more fills the whole section of the tube almost uniformly, but shows no stratifications. In this condition the resistance of the tube becomes enormous, the equivalent spark in air reaching 24 mm. although it was only 1 mm. for no field or weak field. Other experiments show in a clear manner this great increase of resistance. On the other hand, if the magnetic lines of force be in the same direction as the anode rays, there is no increase of resistance even for 7,000 to 8,000 units field strength. Thus the anode stream, like the kathode stream, experiences a very large mechanical resistance to its progress in a direction perpendicular to the lines of force of an intense magnetic field, but experiences a very much more feeble resistance to its progress in the direction of these lines of force. In the latter case, with the ends of the tube inserted into holes in the pole-pieces, the anode column becomes narrowed into a thin cylinder occupying only the axis of the tube, and this is perfectly explained by the result just given. The lines of force, leaving the walls of the holes in the pole-pieces, approach very close to one another between the poles, since the field is more intense there than in the holes. The anode stream takes exactly the shape of this tube of force on account of the difficulty it experiences in cutting the lines of force.

W. C. H.

1873. *Energy of Oscillating Discharge of Condenser in Vacuum-Tube.* **A. Maresca.** (N. Cimento, 3. pp. 337–352, May, 1902.)—In vacuum-tubes the energy expended in the form of heat is $H = A + B/R$ where A and B are constants, and R is the resistance of the discharging circuit. With rising potentials of discharge the energy is approximately proportional to the square of the potential. This applies (Kauffmann *contrà*, Energy $\propto V^3$) also to the case of ordinary gas-pressures. As the pressure falls, the energy expended in the tube increases, reaches a maximum and then diminishes. A. D.

1874. *Absorption of Electric Waves in Liquids.* **K. Wildermuth.** (Ann. d. Physik, 8. 1. pp. 212–226, April 29, 1902. Abstract from Tübingen Thesis.)—The oscillator consisted of two spheres immersed in oil, the waves from which passed along a pair of parallel wires. These in turn passed through a glass vessel containing the liquid under examination. The detector was a thermoelement of iron and constantan joined to a galvanometer. This method allowed the determination of the absorption coefficients for comparatively good and bad conducting liquids. Water, sodium chloride, and copper sulphide solutions behaved normally with waves of a period 21×10^{-10}, *i.e.*, their absorption coefficients are theoretically derivable from their conductivities. For waves of this period dilute ethyl alcohol showed an absorption directly proportional to the mass of absolute alcohol. Waves of a period 74×10^{-11} were more strongly absorbed by distilled water than would be expected from its conductivity. E. H. B.

1875. *Oscillatory Discharge of a Condenser.* **L. Mandelstam.** (Ann. d. Physik, 8. 1. pp. 123–148, April 29, 1902. Strassburg Thesis.)—An indirect method is adopted to determine the frequency of discharge. The oscillatory current is divided into two parallel paths, one containing an inductance, the other a non-inductive (electrolytic) resistance. Each path contains also one wire of a differential thermometer. Matters are adjusted so that the heating effects in the two wires are equal. The frequency is then calculated. In the actual experiments periods of the order $(2 \text{ to } 9) \times 10^{-7}$ second are dealt with.

E. H. B.

1876. *Interference Tubes for Electric Waves.* **A. Becker.** (Ann. d. Physik, 8. 1. pp. 22–62, April 29, 1902. Abstract from Heidelberg Thesis.)—Some of the more important results of this experimental work may be summarised as follows: 1. Using a two-branched Quincke's interference tube and a coherer as detector, the measured length of waves excited by various sources depends only on the cross-section of the tubes, and is about 1·6 times the diameter of the tube. 2. The Quincke's tube with two branches acts as a polariser, allowing only those vibrations to pass which are parallel to its plane. A vertically placed interference tube allows no waves to pass from an oscillator with horizontal axis. 3. By filling the stem of a T-shaped interference tube with an insulating liquid, the wave-length in it and hence its dielectric constant may be determined. 4. The following determinations were made :—

Substance...............	Paraffin	Glass	Carbon disulphide	Alcohol	Water
Dielectric Constant...	2·117	6·37	2·77	16·32	77 to 87

E. H. B.

1877. *Leakage of Electricity.* **H. Mache.** (Akad. Wiss. Wien, Sitz. Ber. 110. 2a. pp. 1302–1306, Dec., 1901. Aus. dem. phys.-chem. Inst. der k. k. Univ. in Wien).—This is a paper on the same lines as one by Elster and Geitel (Phys. Zeitschr. 2. p. 116). Unlike those authors, Mache finds that the leakage is directly proportional to the potential of the charged body, other things remaining the same. If the vessel is closed and the leak from the conductor in it is tested under the same conditions day after day, it is found gradually to increase to about the fourteenth day, after which it remains constant. The leakage is found to be proportional to the pressure of the surrounding gas. A rise in temperature from 16° to 60° is without influence. R. S. W.

1878. *Flower-like Distortion of Coronas due to Graded Cloudy Condensation.* **C. Barus.** (Amer. Journ. Sci. 13. pp. 309–312, April, 1902.)—The author has previously described the distortion caused by non-uniform distribution of the nuclei in the production of coronas of cloudy condensation [see Abstracts Nos. 691 and 1092 (1902)] ; he now works out the shape of the loci of like colour for non-uniform, but horizontally stratified, nucleation Flower-like curves are obtained of types repeatedly met with in working with volatile liquids. He remarks that for benzol the nuclei do not originate in the liquid, but are due to the diffusion of a horizontal conche of nuclei, brooding immediately over the surface of the liquid. W. E. T.

1879. *Rendering Visible the Damping of Electric Oscillations.* **J. Zenneck.** (Ann. d. Physik, 7. 4. pp. 801–805, April 8, 1902.)—The author has shown [see Abstract No. 188 (1900)] how Braun's kathode-ray method may be modified so as to give current curves on a fluorescent screen, which may be photographed. He here points out the suitability of the method for showing how the damping in a condenser circuit depends on inductance, resistance, dimensions, &c., and gives details of a suitable experimental arrangement. W. S.

1880. *Sounds at Electric Contacts.* **M. Hornemann.** (Ann. d. Physik, 7. 4. pp. 862–881, April 8, 1902.)—In passing the current from an induction coil through the human body there is often a sound (not to be confounded with muscle-tone) produced at the contact of skin with electrode ; the frequency coincides with that of the Wagner hammer of the small induction coil. The sound is loudest when skin and electrode are dry, and the contact is light, and when the skin is of a medium conductivity, not horny and not damp. The electrode may be the skin of another person : the direction of the current makes no difference. Weak induction currents favour the loudness of the sound. With higher potentials a single electrode, acting unipolarly, will produce the sound. The sound is due both to thermic effect and to electrostatic forces. With metal contacts in general neither of these causes operates: the interposition of a thin layer of an insulator does not develope sound; but that of a semi-conductor, such as graphite, does; coatings of oxide give variable results, but a thin coating of iron oxide mostly gives good results, even with unipolar oscillations acting through the contact. The contact acts as an indicator both of voltages and of currents. A. D.

1881. *Sounds during Discharges in Tubes or Flames.* **A. Righi.** (Accad. Lincei, Atti, 11. pp. 352–355, May 4, and pp. 457–459, May 31, 1902.)—A circuit contains a battery and 400 small accumulators, a sulphate-of-copper solution resistance R, a condenser, a telephone, and a milliamperemeter; and shunted across from the resistance to the milliamperemeter, a rarefied air-tube with adjustable aluminium electrodes, about $\frac{1}{2}$ cm. apart when the air in the tube is at a pressure of about 1 cm. First produce a tranquil luminous discharge between the electrodes; then close in the condenser branch circuit, and the discharge becomes intermittent, with production of a sound, audible in the telephone. The pitch of the sound increases on diminishing the resistance R, on increasing the number of accumulators in the battery, on diminishing the capacity of the condenser, on diminishing the distance between the electrodes in the tube, and on diminishing the pressure of air in the tube. The frequency of the intermittences may be reduced even to two or three per second, and may be so increased as to pass beyond audibility; but it is practically independent of the self-induction. The condenser is charged and discharged at every intermittence. A Bunsen flame will act like the tube if it be rendered conductive by NaCl vapour. The period of electric oscillations in the condenser circuit was always far less than that of the sonorous oscillations. When these two periods were made equal by increasing the self-induction of the condenser circuit, the phenomena come to resemble those of Duddell; the pitch of the sound becomes almost independent of the e.m.f. of the accumulators or of the resistance R. In intermediate conditions it was noticed that certain pitches of sound seemed possible, others not, so that there were sudden transitions from one pitch to another as the resistance or the self-induction was continuously varied; and in other cases the sound would not start spontaneously without the stimulus of a jar or of the movements of a tuning-fork. A. D.

1882. *Hall Effect in Gases at Low Pressures.* **H. A. Wilson.** (Cambridge Phil. Soc., Proc. 11. pp. 391–397, May, 1902.)—In uniform positive columns of hydrogen and oxygen at pressures below 1 mm. we have the Hall effect in hydrogen Z volts/cm. $= 2{\cdot}05 \times 19^{-2}\mathrm{H}/p$, p being the pressure in mm. Hg, and in oxygen $Z = 3{\cdot}79 \times 10^{-2}\mathrm{H}/p$. In air it is $2{\cdot}48 \times 10^{-2}\mathrm{H}/p$. The electric intensity X volts/cm. $= 28\sqrt{p}$ for hydrogen, $34{\cdot}9\sqrt{p}$ for air, $26{\cdot}9\sqrt{p}$ for oxygen. In a uniform part of the discharge $Z = \frac{1}{2}\mathrm{HX}(k_2 - k_1)$ where k_2 and k_1 are the velocities of the negative and positive ions respectively due to 1 volt/cm. Hence for hydrogen $k_2 - k_1 = 1{\cdot}47 \times 10^5 p^{-1{\cdot}5}$ cm./sec. For air it is $1{\cdot}42 \times 10^5 p^{-1{\cdot}5}$: for oxygen it is $2{\cdot}82 \times 10^4 p^{-1{\cdot}5}$. Along a discharge in air, the Hall effect and distribution of potential in the tube may be made nearly independent of the current. Then the variation of the Hall effect is very similar to that of the electric intensity. In a uniform part of the discharge, $Z = \frac{1}{2}\mathrm{HX}(k_2 - k_1)$, whence $Z \propto X$; but in the striated positive column, the Hall effect falls to an almost zero value between the striæ, whereas the electric intensity only falls to a comparatively small extent; whence $(k_2 - k_1)$ is very small in the dark spaces between the striæ. Probably the negative electron torn off is at first very small and k_2 is relatively large; but by the time they have got into the dark spaces these negative electrons have become attached to neutral molecules so that $(k_2 - k_1)$ is reduced. This view is in agreement with the idea that each stria and its adjacent dark space constitute a to some extent independent portion of the discharge analogous to that formed by the negative glow and Faraday dark space. [See also Abstract No. 1114 (1902).] A. D.

1883. *Light Electric Effect.* **P. Lenard.** (Ann. d. Physik, 8. 1. pp. 149–198, April 29, 1902.)—This is a lengthy continuation of an earlier paper [see Abstract No. 1845 (1900)], on the various effects arising from the incidence of light of short wave-length on metal surfaces. The paper gives the results of experiments when the metal is in a vacuum, and when in a vessel filled with gas. The quantity of electricity discharged is found proportional to the light intensity, provided the quality remains the same. One of two plates U, E, is charged, and the influence of various conditions on the amount of electricity leaving U and reaching E is investigated. It is found, *e.g.*, that a magnetic field normal to the plane of the plates is nearly without influence on the amount reaching E, but lessens that leaving U. An estimate is thus made of the tangential component of the velocity with which the charged ions leave the plate; it is given as $1{\cdot}4 \times 10^8$ cm./sec. The initial velocity of the ions is found independent of the light intensity, but varies with the quality of the light. The position of the plane of polarisation of the incident light is without influence. When the carriers of electricity which are released from the metal surface are shot into a space filled with gas, this is made conducting. R. S. W.

1884. *Stationary Electric Waves.* **K. F. Lindman.** (Ann. d. Physik, 7. 4. pp. 824–850, April 8, 1902.)—Electric waves are generated by an oscillator consisting of two short cylinders with rounded ends. Stationary waves are then produced by reflection from a mirror after the manner of Hertz. Both in the experiments of Hertz and of the present author displacements of the nodes and antinodes from their expected positions of a quarter wave-length apart are noticed. In the present work it is endeavoured to trace these displacements to a phase change at reflection. To investigate this matter the size of the mirror is varied from the order of the wave-length to much larger dimensions. Also as detectors of the waves are used:—(1) A straight resonator with thermoelement; (2) a circular resonator with thermoelement; (3) a resonator with spark-gap. [See also Abstract No. 1317 (1901).] E. H. B.

1885. *Kathode-fall and Current-strength.* **J. Stark.** (Phys. Zeitschr. 3. pp. 274–275, April 1, 1902.)—The normal kathode-fall is independent of gas-pressure and current-strength; but there is some variance as to the abnormal. G. C. Schmidt (Ann. d. Phys. 1. 640, 1900) makes it a linear function of the current-strength. So does C. A. Skinner [see Abstract No. 487 (1902)]. The author finds clearly, however, that their observations were made between too narrow or between unsuitable limits, and that the function is not linear. Hittorf was right in 1884 (Wied. Ann. 21, 129, 1884) in plotting curved lines. A. D.

1886. *Electric Oscillations.* **G. Morera.** (N. Cimento, 3. pp. 382–386, May, 1902.)—In the case of a filiform conductor connecting two charged conductors, Kelvin's formula implies that the two conductors form a perfect condenser, and is not applicable to Hertz's oscillator. In general, if the two conductors have the charge $-\Gamma$ induced in either when put to earth under the influence of the other charged to unit potential (in the case of condensers this is the electric capacity), and if $\gamma_1\gamma_2$ be their respective charges at unit potential, and if R be the resistance and L the self-induction of the wire connecting these two conductors; then the discharge will be oscillatory when—

$$\sqrt[2]{\frac{(\gamma_1+\gamma_2)L}{\Gamma(\gamma_1+\gamma_2)+\gamma_1\gamma_2}} > R\,;$$

and the period of oscillation will be—

$$T = \frac{2\pi}{\sqrt{\frac{\gamma_1+\gamma_2}{\Gamma(\gamma_1+\gamma_2)+\gamma_1\gamma_2}\cdot\frac{1}{L}-\frac{R^2}{4L^2}}}$$

A. D.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1887. *Electric Conductivity in Glowing Electrolytic Bodies.* **E. Bose.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 1. pp. 1–19, 1902.)—This is an investigation of how the current is conveyed in the Nernst incandescent lamp. Marked differences are found, according as a continuous or alternating current is used, and this is proved to be due to electrolytic action. R. S. W.

1888. *Resistance of Selenium at Low Temperatures.* **A. Pochettino.** (Accad. Lincei, Atti, 11. pp. 286–289, April 6, 1902.)—Where the resistance of a selenium cell falls under the impact of light from 31,000 to 18,000 ohms at ordinary temperatures, the resistance of the same cell at the temperature of boiling liquid air falls from 2,600 to 1,900 ohms. This tells against the photo-electric effect (0·4 in the former, 0·3 in the latter case) being due to chemical reactions, say between selenium and metal, which reactions are absent in the latter case. A. D.

1889. *Large Influence Machine.* **O. Brooks.** (Journal of Electricity, S.F. 12. pp. 87–88, May, 1902.)—Description is given of a large double influence machine in which there is a double row of neutralising pins to secure a more perfect discharge of the plate surfaces after passing the collecting combs, and in which the inductor field plates on one side are metallically connected with the collecting combs. This last feature is unorthodox, but it seems to increase the reliability very much, and to prevent reversal of polarity. A. D.

ALTERNATING CURRENTS AND MAGNETISM.

1890. *Oscillatory Charging Currents.* **H. Andriessen.** (Ann. d. Physik, 7. 4. pp. 912–918, April 8, 1902.)—In these experiments the usual practice is reversed, and a study made of the oscillatory currents that may occur in charging a condenser with a spark-gap in circuit. It is found that condensers allow a much greater current to pass than would be inferred from the voltage, capacity, and frequency used. The ramified sparks seen on the Rosetti plate and the phenomena termed side-discharges are held to be the cause of oscillatory charging currents. Air insulation at high voltages is disadvantageous because oscillatory sparks occur there. The superiority of oil insulation lies partly in its avoidance of such sparks. [See also Abstract No. 1367 (1902).]

E. H. B.

1891. *The Electrometer in Alternate Current Measurements.* **K. Hohage.** (Elektrotechn. Zeitschr. 23. p. 365, April 24, 1902.)—The electrometer is used in conjunction with a small 2-pole alternator mounted on the main alternator shaft, and having its field magnets arranged so that they are capable of being displaced through a known angle about the armature shaft. The armature of this little auxiliary machine is wound with a large number of turns of fine wire, and developes a fairly high e.m.f. It is evident that by displacing the field magnets the phase of the auxiliary e.m.f. may be varied at will while its magnitude remains constant. This auxiliary e.m.f. of variable phase is introduced between the needle of the electrometer and one pair of quadrants. The arrangement may now be used for measuring an alternating current and its load and idle components by the following method : Included in the main circuit of the generator is a small resistance r (not necessarily non-inductive), whose terminals are connected to the two pairs of quadrants of the electrometer arranged as described above. If the generator is first loaded non-inductively, and the field magnet of the auxiliary alternator rotated until a maximum deflection is obtained, then the field-magnet position will correspond to a co-phasal relation of the auxiliary e.m.f. and the p.d. across r, and the maximum electrometer deflection will be proportional to the current. Let now the load be an inductive one; then in order to obtain a maximum deflection the field magnet of the auxiliary machine must be rotated from its standard position (found as described) through an angle θ equal to the phase-difference between the p.d. and current in the main circuit. The maximum deflection is proportional to the total current ; the deflection in the standard position, to the load current ; and that in a position at right angles to the standard one, to the idle current. A. H.

1892. *Magnetism Induced by Rapidly Oscillating Currents.* **W. M. Varley.** (Phil. Mag. 3. pp. 500–512, May, 1902.)—The object is to find how the magnetisation depends on the strength and frequency of the currents and on the diameters of the iron wires used. Frequency depends on the product L.C. (inductance and capacity), whereas the maximum current depends on the ratio C/L. Hence, if care be taken to maintain the product constant, the dependence of the magnetisation on the field-strength alone can be found ; but if the ratio is maintained constant, the dependence of the magnetisation on the frequency alone is found. Both the maximum current and the magnetisation produced were measured by Braun's method of using the deflection of kathode rays. An oscillating current was produced by discharging Leyden jars through a micrometer spark-gap, and various coils. The values of the inductances were either calculated or found experimentally. The results show that (1) magnetisation increases as the magnetising current increases; (2) magnetisation decreases as the frequency increases ; (3) magnetisation, for the most rapid frequencies, is proportional to the surface of the iron, except for the thinnest wires. This shows that, for these frequencies (about 130,000 per sec.), the magnetisation only penetrates to the centre of the wire in the case of the thinnest wire used. P. E. S.

1893. *Magnetism and Thermal Conductivity of Iron.* **D. Korda.** (Soc. Franc. Phys., Séances, 3. pp. 288–292, 1901.)—In Abstract No. 1041 (1899) will be found a description of the method used by the author to show that conductivity decreases along the lines of magnetic force and remains unaffected across those lines. In the present paper, besides the above method, he describes experiments on rods of iron, the same result being found. P. E. S.

1894. *Null Method for Magnetic Measurements.* **R. Goldschmidt.** (Elektrotechn. Zeitschr. 23. pp. 314–315, April 10, 1902.)—Suppose two bars have to be compared as to their permeability. A primary coil is wound round each in series. A secondary coil is also wound round each in series, but the turns are so adjusted that when current starts in the primary there is no current in the secondary as measured in a millivoltmeter. In that case a simple proportion exists between the lines of force in the two bars and the turns in their respective secondary coils.

This simple method has been used in many ways, *e.g.* (1) for bars, (2) for dynamo pole-pieces, (3) for investigating the actual increase in magnetic resistance in an iron ring which has a thin air-gap in it. P. E. S.

1895. *Distance between the Poles of a Magnet.* **C. Benedicks.** (Journ. de Physique, 1. pp. 302–307, May, 1902.)—In a bar magnet it is easy to find the magnetic moment and the strength of each pole (by a coil for induction at the centre of the bar) and hence the distance between poles can be determined. The ratio l/L, where $l =$ distance between poles and $L =$ length of magnet, is not approximately constant $(=\frac{5}{6})$, as Kohlrausch found; on the contrary, the ratio steadily increases to a limit as the magnetising field increases. The curve for l/L, as H varies, is the inverse of the curve for susceptibility and H. P. E. S.

ELECTROPHYSIOLOGY AND ELECTROTHERAPEUTICS.

1896. *Electric Properties of Nerves.* **V. Grandis.** (Accad. Sci. Torino, Atti, 37. 10a. pp. 215–220, 1901–1902.)—The results previously obtained by the author [see Abstract No. 2181 (1901)], and attributed by him to magnetic lines of force, he now attributes to electrostatic induction. Charging a nerve negatively, whether by conduction or by induction, causes excitation; charging positively has no such effect. Galvani discovered this, but it had been forgotten. Every variation in negative charge induces muscular contraction. Nerve seems to be rather a dielectric than a conductor; different points of it can be at different potentials, there can be oscillations of potential values in it, and it has a resistance of 7,000 ohms per cm. A. D.

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1897. *Potential Measurement.* **F. Henning.** (Ann. d. Physik, 7. 4. pp. 893–904, April 8, 1902.)—Apparatus is described for measuring air potentials with a flame, and a collector consisting of a radio-active substance, to render the air conductive. Quantitative comparative measurements are given. A. D.

1898. *Ionic Theory of Leakage of Electricity from Charged Bodies.* **J. Stark.** (Ann. d. Physik, 7. 4. pp. 919–931, April 8, 1902.) R. S. W.

1899. *Photographic Study of the Electric Discharge.* **K. Przibram.** (Akad. Wiss. Wien, Sitz. Ber. 110. 2a. pp. 960–963, 1901.)—A continuation of an earlier paper. [See Abstract No. 2448 (1900).] R. S. W.

1900. *The First Layer of Kathode Light.* **E. Goldstein.** (Deutsch. Phys. Gesell., Verh. 4. 5. pp. 64–71, March 7, 1902.)—The paper contains an account of observations on the layer of light which comes between the Crookes' dark space and the surface of the kathode. [See also Abstract No. 707 (1902).] R. S. W.

1901. *Oscillations in Distributing Networks.* **Brillouin.** (Comptes Rendus, 134. p. 768, April 7, 1902.)—Pomey's result [see Abstract No. 1713 (1902)] was shown by the author in 1881, and previous to this by Helmholtz in 1851 in Ann. Phys. 73. pp. 513–514. A. D.

1902. *Stationary Electric Waves on Wires by Condenser Discharges.* **F. Braun.** (Ann. d. Physik, 8. 1. pp. 199–211, April 29, 1902.)—A discussion, descriptive and mathematical, of various arrangements for obtaining stationary waves along wires. The paper is illustrated by nine figures. E. H. B.

1903. *Walter's Röntgen-Ray Apparatus.* (Elect. Rev. 50. pp. 755–757, May 9, 1902.)—This is a practical account of Walter's induction coil for use with the Wehnelt electrolytic break for Röntgen-ray tubes. [See Abstracts Nos. 38, 311, 1728 (1899), 845 (1902).] A. D.

1904. *Effect of Shape of E.M.F. Wave on Current.* **A. Russell.** (Elect. Rev. 50. pp. 920–921, May 30, 1902.)—The author considers the following cases: (1) a circuit containing resistance and inductance; (2) one containing resistance and capacity; (3) a circuit consisting of an inductive resistance in series with a capacity. In each case an expression is obtained, in the form of a Fourier series, for the current due to an impressed e.m.f. represented by a Fourier series. A. H.

1905. *Motion of Electrolytes in a Magnetic Field.* **O. Urbasch.** (Zeitschr. Elektrochem. 8. pp. 150–153, March 6, 1902.)—The author replies to Drude [see Abstract No. 1113 (1902)], and reaffirms his former experimental results. [See Abstract No. 107 (1901).] A. D.

1906. *Motion of Electrolytes in a Magnetic Field.* **P. Drude.** (Zeitschr. Elektrochem. 8. pp. 229–230, April 24, 1902.)—The author replies to Urbasch (see preceding Abstract) that with the same electromagnet and arrangement as used by Urbasch he obtains no such rotation. He thinks the motion observed must have been the irregular surface-tension motions due to laying water upon concentrated sulphuric acid. A. D.

1907. *Reports on Magnetic Observations made during the Total Solar Eclipse of May,* 17–18, 1901. **W. Kesslitz,** Polar Magnetic Observatory, Austria; **T. Moureaux,** Val-Joyeux Magnetic Observatory, France; **W. Haga,** Groningen University; **M. Snellen,** de Bilt Meteorological and Magnetic Observatory, Holland; **van Rijckevorsel,** Vlissingen, Holland; **C. Börgen,** Wilhelmshaven Magnetic Observatory; **M. Eschenhagen,** Potsdam Magnetic Observatory; **H. A. D. Fraser,** Dehra Dún, India; **J. de Moidrey,** Zi-Ka-Wei Magnetic Observatory, China; **C. C. Farr,** Christchurch, New Zealand; **G. L. Hosmer,** Sawah Loento, Sumatra; and **T. F. Claxton,** Royal Alfred Observatory, Mauritius Island. (Terrestrial Magnetism, 6. pp. 123–143, Oct.; and pp. 167–184, Dec., 1901.)

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1908. *Determination of Molecular Weight by the Boiling-point Method.* **E. Beckmann.** (Zeitschr. Phys. Chem. 40. pp. 129–157, March 25, 1902. Communication from the Laboratory for Applied Chemistry of the Leipzig University.)—The author gives a description of his original apparatus for the carrying out of this method, and also of the various modifications of it made by different investigators. A new apparatus is also depicted and described, the heating of the solution being effected by means of a current of the vapour of the solvent. A number of determinations of the molecular weights of different substances show that the new apparatus yields very accurate results. Comparison is made between the two methods of boiling the solution—by direct heating, and by means of a current of the vapour of the solvent—each of these having certain advantages. T. H. P.

1909. *Molecular Weights of Carbon Compounds in Concentrated Solutions in Organic Solvents.* **C. L. Speyers.** (Amer. Journ. Sci. 13. pp. 213–223, March, 1902.)—The author has previously shown [see Abstract No. 1703 (1900)] that the equation $n/(N+n)=(p-p')/p$ (1) expresses the vapour pressures of mixtures of liquids miscible in all proportions better than does the equation $n/N=\log p/p'$ (2); $p-p'$ being the diminution in vapour pressure produced by the addition of n molecules of one liquid to N of the other. Since then von Zawidzki [see Abstract No. 171 (1901)] has applied Margules' equation to such mixtures, but the author considers that this is more complicated than equation (1) and gives no better results. As some disturbing element may have been overlooked in the development of van't Hoff's law when the solute is a volatile liquid, the author has made a number of measurements of the relative depression of the vapour pressure for concentrated solutions of non-volatile solutes. The boiling-point method giving unsatisfactory results with such concentrated solutions even when reduced pressures are employed the author makes use of a modified form of Walker's method. The results given refer to solutions of urea and resorcinol in water; urea, acetanilide and naphthalene in methyl alcohol; acetanilide, acenaphthene, naphthalene, urea, benzamide and resorcinol in ethyl alcohol; acenaphthene and naphthalene in propyl alcohol; naphthalene and acenaphthene in toluene. The numbers show that in no single case does formula (2) give very satisfactory results, but that this is sometimes the case with formula (1). The formula (1) is, however, an arbitrary one, as it makes use of the molecular weight of the solvent in the gaseous state and not that of the liquid solvent. The following equation, which the author now brings forward, only requires a knowledge of the molecular weight of the solvent in the vaporous state: $\log(n/N+1)=Q'(T_1-T_0)/RT_1T_0$; Q being the heat of vaporisation of one grammolecule of solvent from the solution the quantity of which is so great that no change in concentration is effected when the grammolecule is removed; T_1 represents the boiling-point of the solution, T_0 that of the pure solvent, and R is the gas solvent. The equation is available for determining either molecular weights according to the boiling-point method or the latent heat of vaporisation of the solvent. It answers all purposes to which van't Hoff's formula is put and is independent of the osmotic theory. T. H. P.

1910. *Position of Rare Elements in Mendelejeff's Periodic System.* **B. Brauner.** (Jurn. Russk. Fisik. Chimičesk, Obščestva, 34. 1a. 2. pp. 4–5, and 2a. 1. pp. 142–153, 1902.)—The author examines all the possible positions of the metals of the rare earths in Mendelejeff's periodic system, the conclusion arrived at being that this group of elements may present some analogy with the group of asteroids in the solar system, forming, in the periodic system, a sort of link between cerium and the unknown element of the atomic weight 180. This interperiodical group is thus the continuation of the eighth line, terminating with the wolfram-platinum elements; gold is shown to be the first term of the ninth, and not of the eleventh line. The first element of the twelfth line is probably radium, followed by thorium and uranium.

A. G.

1911. *Catalysis of Hydroxylamine and of Hydrazine.* **S. Tanatar.** (Zeitschr. Phys. Chem. 40. pp. 475–480, April, 1902.)—In cases of catalysis, where there are bye-products it is conceivable that the catalyser may favour some one of the chemical changes in operation, so that the quantitative distribution of the products will be different with and without the catalyser. The author presents the first accurately investigated case of this kind. Hydroxylamine solutions decompose on warming, chiefly according to the equation $3NH_2OH = N_2 + NH_3 + 3H_2O$. At the same time nitrogen monoxide is produced to a small extent according to the equation—

$$4NH_2OH = 2NH_3 + N_2O + 3H_2O.$$

It is found that if the decomposition takes place in presence of platinum black, nitrogen monoxide becomes the primary, and nitrogen the secondary product. The author suggests that the platinum is changed to a suboxide by oxygen from part of the hydroxylamine; the oxide of platinum would then oxidise another part of the hydroxylamine. This explanation is not, however, easily applied to the case of hydrazine (as sulphate), which also quickly decomposes, with evolution of nitrogen, in presence of platinum black: the hydrazine contains no oxygen for the formation of an oxide of platinum.

D. H. J.

1912. *Separating Crystals from Alloys.* **C. van Eyk.** (Konink. Akad. Wetensch. Amsterdam, Versl. 10. pp. 859–862, April 19, 1902.)—After discussing the various methods used to ascertain the structure and constitution of alloys, the author suggests separating crystals from the mother-liquor, by means of a centrifugal device, the temperature at which crystals begin to separate out from the molten alloy being previously determined. This method will in most cases afford a means of ascertaining whether pure metals, compounds, or mixed crystals are separated out, the composition of the crystals obtained changing regularly in the latter case. A. G.

1913. *Limitations of the Mass Law.* **W. D. Bancroft.** (Journ. Phys. Chem. 6. pp. 190–192, March, 1902.)—The author adduces cases to show that, even where the molecular weight of each reacting substance is constant, and where Henry's law holds absolutely for each of them taken singly, the orthodox mass law equation will not apply in the solution, if any one of the reacting substances influences the partial pressures of any of the others either positively or negatively. Nernst and Luther, in showing that the dissociation of a compound in solution can be deduced from the dissociation in the vapour provided Henry's law holds for the compound and its dissociation products, had assumed Dalton's law, that each substance in the vapour phase is absorbed proportionally to its partial pressure and independently of the nature of the other absorbed substances, which is not always true. When this law holds, the effect due to the nature of the solvent will be seen in the change of the equilibrium constant, the more soluble system increasing at the expense of the other, which the author shows to be consistent with Berthollet's law. W. E. T.

1914. *The Phase-Rule.* **J. E. Trevor.** (Journ. Phys. Chem. 6. pp. 185–189, March, 1902.)—The author obtains a new derivation of Gibbs' phase-rule by considering the energy of each of the coexistent phases as a function of the volume, entropy, and component masses, and the differentials of these functions, and comparing the number of equations of condition that must be satisfied, with the number of the variables. W. E. T.

1915. *Synthetic Analysis of Solid Phases.* **W. D. Bancroft.** (Journ. Phys. Chem. 6. pp. 178–184, March, 1902.)—Reversing the method of van Bijlert [Zeit. Phys. Chem. 8, 343 (1891)], the author deduces the composition of a solid phase by analysing, and thus determining the change in composition of, the solution from which it separates. A second analysis with different initial and final concentrations decides whether the solid phase is a solid solution or a compound, as its composition varies in the former case. If a third component may enter into the solid phase, the results are best interpreted graphically. Sometimes direct analysis of the solution is difficult and it is better to employ a zero method. Thus an assumed constitution of the solid phase may be tested by adding to a saturated solution one or more components in the assumed proportions and keeping the solution at the adopted temperature until equilibrium is attained; if the assumed proportions are correct, the solution will be unchanged, as may be verified by determining any of its convenient properties. In the case of alloys, the breaks in the temperature-time cooling curves may be used and the alteration which is produced in them by the addition of one or more components. W. E. T.

1916. *Synthesis of Dimethyl-succinic Acid under the Influence of Light.* **W. Zermoff.** (Jurn. Russk. Fisik. Chimičesk, Obščestva, 34. 2a. pp. 140–142, 1902.)—Among the reactions occurring under the influence of light between organic bodies, there are some known cases of synthesis. The author investigates that of α-iodpropyl ether, which, on being exposed to the sunlight together with mercury, is converted into dimethyl-succinic acid. A. G.

1917. *Gelatinisation.* **S. Levites.** (Jurn. Russk. Fisik. Chimicesk, Obščestva, 34. 2a. pp. 110–119, 1902.)—The author studies the delay of gelatinisation of some colloidal bodies from an aqueous solution, produced by the addition of salts or other substances. It is shown that this effect increases with the temperature; in some cases, the gelatinisation process is found to be wholly prevented. The facts observed afford evidence of the proposition suggested by the author, that a given colloid will undergo gelatinisation from a given salt solution more slowly, the more readily it dissolves in this solution. Some striking analogies between this process and the process of crystallisation are finally pointed out. A. G.

1918. *Solubilities of Calcium Salts of the Acetic Series.* **J. S. Lumsden.** (Chem. Soc., Journ. 81. and 82. pp. 350–362, April, 1902.)—The solubilities of the calcium salts of the first nine normal acids of the acetic series and of isobutyric and isovaleric acid were determined. The solubilities increase up to the propionate and then decrease again, the solubility of the butyrate being equal at 83° to that of the formate, whilst higher homologues are much less soluble. The formate separates in an anhydrous form, but all the other salts with $1H_2O$, though the acetate separates below 84° with $2H_2O$, the isobutyrate below 62° with $5H_2O$ and the isovalerate below 46° with $3H_2O$. In almost every case the solubility-curves are convex to the axis of temperature, and exhibit a temperature of minimum solubility.

T. M. L.

1919. *Decomposition of Organic Halogen Compounds in Alcoholic Solution by Sodium Amalgam.* **R. Löwenherz.** (Zeitschr. Phys. Chem. 40. pp. 399–439, April, 1902.)—In the experiments here described, a quantity of sodium-amalgam was added to the alcoholic solution of an organic compound, and a determination was made from time to time, in samples of the reaction mixture, of the quantity of sodium which had reached and of the quantity of halogen which had split off. A similar series of experiments has already been described by the author (Zeits. Phys. Chem. 32. 477, 1900), where sodium replaced the sodium amalgam: it was found that, with sodium, the course of the reaction was the same for all the compounds investigated, and could be expressed by the formula $k = 1/(\mathrm{Na}) \times \log\left\{a/(a = x)\right\}$, where k is a constant called the utility-effect (Nutzeffekt), (Na) is the dissolved quantity of sodium in gram-atoms in one kilogram of solution, a is the original quantity of the halogen body, x the quantity decomposed. In the case of sodium amalgam, it appears that the reaction is much more complex than with sodium, and cannot be expressed by the simple formula given above; the experiments made with iodobenzene showed that the decomposition was not proportional to the concentration except, possibly, for very small concentrations; no definite results could be obtained with bromobenzene as the results varied with the rate of stirring. An addition of water markedly influences the decomposition of iodobenzene by sodium, not by sodium amalgam, and the amount of decomposition of iodo- and bromo-compounds is greater when the amalgam is used. In the latter case, too, the reaction is little affected by temperature, by the extent of surface of the amalgam, by the substitution of amyl for ethyl alcohol or of lithium or potassium for sodium; the concentration of the amalgam affected the decomposition of iodobenzene, not of bromobenzene.

D. H. J.

1920. *Aqueous Solutions of Inorganic Salts.* **W. Biltz.** (Zeitschr. Phys. Chem. 40. pp. 185–221, March 25, 1902. Communication from the Göttingen University.)—Determinations were made of the molecular depression of the freezing-point, lowering of the vapour pressure at 25°, and elevation of the boiling-point of aqueous solutions of a wide range of salts. According to the simple laws of dissociation these effects should be greatest at great dilution, approximating in the case of binary salts to twice the values for non-electrolytes, and for ternary salts to a threefold value. In a number of cases, however, values are obtained for moderately strong solutions which are greater than the values in dilute solution, a minimum being reached at intermediate dilutions [see Abstract No. 915 (1902)]; in some cases values are obtained in concentrated solutions which are even greater than those required for complete dissociation; thus, the molecular depression of the freezing-point for $MgBr_2$ in N/2 solution is 58·4, the value calculated for complete dissociation being only 55·5.

These effects are not very marked in the case of the alkaline chlorides; in the series Cs, Rb, K, NH_4, Na, Li, cæsium behaves most normally, but lithium (the least normal member of the series) shows a steady increase with increasing concentration in the molecular depression of the freezing-point; a similar gradation occurs in the case of the lithium and potassium salts of the radicles NO_3, Cl, Br, I, the nitrates being most normal and the iodides most abnormal. The chlorides of the divalent metal Ba, Si, Cu, Zn, Mn, Ca, Ni, Co, Mg, Fe all exhibit a pronounced minimum of molecular depression of the freezing-point at about 0·2N; the curves illustrating this are very striking, the minimum being least marked in the case of $BaCl_2$, and most in the case of $MgCl_2$ and $FeCl_2$.

General confirmation of the results obtained for the molecular depression of the freezing-point was obtained by studying the elevation of the boiling-point and lowering of the vapour pressure. In explanation of these very remarkable results it is suggested that the salt combines with the solvent to form hydrates, whereby the mass of the free solvent is materially reduced, especially in concentrated solutions, and the osmotic constants are correspondingly increased. In support of this view it is pointed out that the molecular heat of solution of the chlorides of the divalent metals Ba, Sr, Cu, Zn, Mn, Ca, Fe, Co, Ni, Mg, increasing from Ba to Mg, leads to an arrangement of these metals which differ from the cryoscopic arrangement given above only in the displacement of Fe and the interchange of Ni and Co. Moreover, the molecular heats of solution increase in the series K, NH_4, Na, Li, and with only two exceptions in the series NO_3, SCN, Cl, Br, I, the thermal arrangement of the binary salts being also in agreement with their cryoscopic behaviour. Opposite effects would be produced by polymerisation of the dissolved salt, as in the case of aluminium bromide, which in solution, as in the gaseous state, consists largely of Al_2Br_6. The most normal behaviour is found in the cæsium salts and in the nitrates, and the cryoscopic behaviour of cæsium nitrate was therefore determined; the value $\frac{a^2}{(1-a)v}$ was found to be constant up to 4·84N, and this salt is the first strong electrolyte that has been found to obey the dissociation law. The values of a λ/λ_∞ determined from the conductivity do not, however, give a steady dissociation-constant.

T. M. L.

1921. *Inversion of Zinc Sulphate.* **H. T. Barnes** and **H. L. Cooke.** (Journ. Phys. Chem. 6. pp. 172–177, March, 1902.)—So far measurements of the temperature of inversion by means of the Clark cell have shown a marked difference from those obtained by measurements of solubility. Thinking that this might be due to the mercurous sulphate in the Clark cell, the authors constructed two H-form cells, one of which was filled simply with zinc sulphate crystals and solution over zinc amalgam, the other containing mercurous sulphate and zinc sulphate paste over mercury. The sulphate in one limb was inverted, and then the e.m.f. measured at various temperatures near the temperature of inversion. The results obtained for the two cells showed a small difference, but not so large as the difference in question.

W. R. C.

1922. *Secondary Reactions in Gas-Cell.* **E. Biron.** (Jurn. Russk. Fisik.-Chimičesk, Obščestva, 33. 6. pp. 424–480, 1901.)—In this paper the following combination—

Pt (saturated with air) ‖ HCl (aqueous) ‖ Normal electrodes

is investigated, the secondary reactions produced by the catalytic effect of platinated platinum electrodes being accounted for. The author maintains that the chlorine evolved at this electrode, and reacting upon it, causes the electromotive force of this cell to fall, which accounts for the abnormally small values of the same, as given by previous investigators. A. G.

1923. *Electromotive Forces of Metals in Cyanide Solutions.* **S. B. Christy.** (Elektrochem. Zeitschr. 8. pp. 49–58, June; 75–88, July; 104–108, Aug.; 133–135, Sept.; 159–163, Oct.; 181–186, Nov.; 198–207, Dec., 1901; and pp. 221–231, Jan., 1902.)—The relative affinities of metals are measured by their tendency to dissolve in potassium cyanide solutions. The values of the e.m.f.s of a large number of metals, alloys, and minerals in cyanide solutions of various strengths are examined, and the result expressed by means of curves. Two methods are used for determining the electromotive forces. In the first case, a cell containing the cyanide solution, and the metal as electrode, is connected by means of a tube and siphon containing $\frac{M}{1}$ KCl solution with an Ostwald's normal electrode. This combination is placed in circuit with a large resistance varying from 80,000 to 200,000 ohms, and a Wiedemann galvanometer. The Ostwald's electrode was calibrated by means of a Latimer-Clark standard cell. Its e.m.f. was 0·560 volt. The e.m.f. found is either the sum or difference of that of the normal electrode and of the metal in the KCN solution, according as the currents from each are in the same or in opposite directions. The other method used was a Null method; the circuit consisted of two parts, one containing the combination of the cyanide cell and the normal electrode, the other in circuit with an accumulator having a constant e.m.f. of 2 volts. The position of a sliding contact, on a resistance divided into 10,000 parts, was altered until no deflection was produced in the galvanometer on closing the circuit. The results are best shown by means of curves, but a short summary of results is also given. The electrochemical order of the metals in $\frac{M}{1}$ or 6·5 per cent. KCN solution is zinc, copper, gold, silver, lead, mercury, iron, and is completely different from their order in distilled water. The latter is zinc, lead, iron, copper, silver, mercury, gold, and is the same as that in acid solutions, except that iron stands before lead. All these metals show a critical point which lies at a dilution of between M/1000 and M/10000 of the cyanide solution; at these points the potential of most of the metals changes from + to −; this would appear to be due to the fact that at this point the complex ions are completely dissociated. The form of the curves for iron and lead are different from those of the other metals; in the case of iron the results are not quite satisfactory, owing to the formation of deposits. The rest of the paper is devoted to the examination of the power of dissolving gold, possessed by cyanide solutions of different strengths. At the beginning of the paper there is a critical abstract of recent work on solution and ionisation. W. C. B.

1924. *Measurement of Ionic Velocities.* **B. D. Steele.** (Roy. Soc., Phil. Trans. 198. pp. 105–145, Feb. 18, 1902. Abstract in Roy. Soc., Proc. 68. pp. 358–360, July 9, 1901.)—This paper is largely a recapitulation of previously published work [see Abstract No. 1555 (1901)]. The author obtains for the sums of the anion and kation velocities numbers which agree well with those calculated from Kohlrausch's conductivity figures. The ratio of the current as measured and as calculated from the velocity of the margins is equal to unity for a few salts of the potassium chloride type, but for other salts the ratio is sometimes greater and sometimes less. The author shows that where a change in transport number occurs with changes in concentration, this is due to complex ions rather than to a change in ionic velocities. It was observed that the melting-point of the jellies depended on the nature of the anion and the kation, being more or less additive. W. R. C.

1925. *Voltameters with Antimony, Bismuth, and Cadmium Electrodes.* **G. A. Berti.** (Elettricista, Rome, 11. pp. 100–102, April, 1902.)—The phenomena observed in voltameters which have electrodes of aluminium or magnesium, placed in an electrolyte yielding oxygen at the anode, have been known for some time [see Abstracts Nos. 1159 (1901), 749 (1902)]. The author has observed quite similar phenomena with electrodes of antimony (in presence of acid, alkaline, or ammoniacal electrolytes), of bismuth, and of cadmium (with ammoniacal electrolytes). Neutral oxalate of ammonium forms the best electrolyte for cadmium, ammonium carbonate for bismuth and ammonium carbonate or sulphuric acid for antimony. The following table gives some of the results obtained with a voltameter containing sulphuric acid (sp. gr. 1·298), in which were immersed an antimony anode (12 cm.^{2}) and a platinum kathode (9 cm.^{2}) placed at a distance of 4·5 cm. from one another :—

P.D. at electrodes	5·9	9·62	13·2	22	35	38·4	43·5	45 volts.
Current …………	0·034	0·054	0·073	0·148	0·256	0·56	6·45	9·2 amperes.

The luminous phenomena began a little above 38 volts and increased till, at about 45 volts, there was the appearance of a beautiful fluorescence at the anode. D. H. J.

1926. *Tests of Improved Voltameter.* **T. W. Richards** and **G. W. Heimrod.** (Amer. Acad., Proc. 37. pp. 415–443, April, 1902.)—The improved silver voltameter, in which the anode is surrounded with a porous pot, has already been described [see Abstract No. 889 (1900)]; the present paper records a series of tests made with the instrument. These show (1) that the mean difference between two such voltameters in series amounts to only 0·004 per cent.; (2) that the deposit is unaffected by coating the lower part of the cup with paraffin, in order still further to reduce the possibility of contaminating the kathode-liquor by complex products formed at the anode; (3) that the average difference on using a zinc in place of a silver anode is only 0·001 per cent.; (4) that results differing on the average by less than 0·004 per cent. are obtained when an anode plate is placed *below* a wire-gauze kathode; this device, though troublesome, serves equally well to prevent contamination of the kathode by the heavy products formed at the anode, and the identity of results shows that no new error is introduced by the use of the porous pot. The conclusion is drawn that the porous cup voltameter affords a means of depositing the amount of silver which really corresponds to the quantity of electricity sent through it. An investigation of the separate effect of each anode irregularity showed that nitrite is formed at the anode

($AgNO_3 + 2Ag = AgNO_2 + Ag_2O$), but probably has no effect on the deposit; a solution *saturated* with nitrite gives a heavier deposit, as the nitrite decomposes in the light with separation of silver; the formation of nitrite tends to neutralise an acid solution, as was observed by Roger and Watson with 30 per cent. $AgNO_3$, but in dilute solutions acid is produced. The main irregularity is apparently the formation of a complex ion such as $\overset{+}{Ag}_3O$, which when deionised at the kathode would deposit, in the form of $Ag + Ag_2O$, more than three times the normal weight of material; this view involves the formation in the solution of a basic salt such as Ag_2O, $AgNO_3$, and is in accordance with the facts (1) that the anode irregularity is accompanied by liberation of acid; (2) that similar high values result when the solution is saturated with Ag_2O; (3) that normal values are again obtained when the boiled solution is afterwards acidified; (4) that very high results were obtained by Rayleigh in presence of silver acetate, which would prevent the separation of any acid stronger than acetic, and would therefore favour the formation of basic salt. In Rayleigh's voltameter the deposit on silver is 0·01 per cent. heavier than on platinum; this difference does not occur in the improved voltameter, and is therefore due to the formation at the anode of a compound from which silver is readily deposited as if from a supersaturated solution. That this is actually the case was proved by transferring the anode solution to a platinum crucible containing deposited silver, when it was found in four successive experiments to deposit on the average 0·33 mg. of silver or some silver compound; silver nitrate solution through which no current has been passed does not produce this effect. The formation at the anode of a silver-depositing complex would also account for the copious formation of anode-dust. It is suggested that the silver at the anode dissolves largely as $\overset{+}{Ag}_3$, and that this unstable ion breaks down with liberation of silver, mainly at the anode, but also at the kathode if allowed to reach the latter. The existence of a "peroxide" is also referred to as a fourth irregularity. The loss in weight of the deposits when ignited averaged 0·018 per cent., due to included mother-liquor; this is of importance where absolute results are required, but for purposes of comparison the unignited precipitates may often be used. The true electrochemical equivalent of silver is probably 1·1175 mg. per coulomb, and the number of coulombs per equivalent 96,580. The electrochemical equivalent of copper, by comparison with silver deposited in series, is 0·32929 mg. per coulomb, corresponding with an atomic weight 63·601 ($Ag = 107{\cdot}92$, $O = 16{\cdot}00$) as compared with the value 63·604 deduced from atomic weight determinations. T. M. L.

1927. *Conductivity of Solutions of Mixed Electrolytes.* **H. Wolf.** (Zeitschr. Phys. Chem. 40. pp. 222–255, March 25, 1902.)—The lowering of the electrical conductivity of a dilute aqueous solution (0·0282N) of KCl or NaBr, amounts to about 8·2 per cent. for each equivalent of acetic acid added to 1 litre of solution, after allowing for the conductivity of the acid. The increase of viscosity amounts to 12·3 per cent. for each equivalent of acetic acid (Reyher, Zeitschr. 2. 757, 1888) or $\frac{3}{2}$ times as great as the decrease of conductivity.

The decrease of conductivity by the addition of alcohol is 13·5 per cent. per equivalent per litre; and the increase of viscosity (Arrhenius, Zeitschr. 1. 298, 1887) is 26·8 per cent., the ratio here being 2 : 1. In the case of more concentrated solutions (0·25N and 0·50N KCl) the lowering of conductivity by alcohol is almost constant at 13·9 per cent. per equivalent per litre, but the lowering of conductivity by acetic acid increases to 9·7 and 10 per cent.;

probably in the latter case there is a more marked lowering of the degree of dissociation of the salt, than in the former case, the dielectric constant of alcohol being higher than that of acetic acid. [See also Abstract No. 1161 (1902).] T. M. L.

1928. *Limiting E.M.F.'s in Electrolysis.* **Berthelot.** (Comptes Rendus, 134. pp. 873–876, April 21, 1902.)—Experiments are described on the decomposition of acidulated water, and also of a neutral salt, at atmospheric pressure and in vacuo, using platinum wires as electrodes (Wollaston electrodes). Gas is not evolved at both poles with 1·5 volts, even in vacuo, but evolution takes place with 1·6 volts. When pyrogallol was present at the positive, hydrogen was evolved at the negative between 0·80 and 0·70 volt. The e.m.f.'s were found by knowing the e.m.f.'s of the cells applied, apparently not by measurement. W. R. C.

1929. *The Rhodin Electrolytic Process for Manufacture of Alkali and Bleach at Sault Sainte Marie, Ontario.* **B. E. F. Rhodin.** (Soc. Chem. Ind., Journ. 21. pp. 449–451; Discussion, p. 451, April 15, 1902.)—A paper read by the author before the first meeting of the Canadian section of the Society in Toronto on March 6, 1902. The power used at these works is derived from the fall of 19 ft. at Sainte Marie, and the power costs 0·136 cents per lb. of manufactured products. The cells are of the ordinary Rhodin type, and each takes a current of 800–1,000 amperes at an e.m.f. of 5 volts. The inner chamber of each cell is 8 ft. in diameter, the outer cell is 5 ft. Acheson graphitised carbons are employed as anodes, and the hydrogen produced by secondary reactions in the cell only amounts to 8 per cent. of the chlorine. The present power plant of the company consists of three 220-kw. generators, each driven by a separate turbine. The decomposing plant consists of 120 cells, while the bleaching powder is produced in 10 chambers of the usual design. In 1901 only a portion of the plant was operated, the daily output being 4 tons 800 lbs. bleach, and 2 tons caustic soda. The bleach produced contains 37–38 per cent. available chlorine, and the caustic 74–76 per cent. Na_2O. As soon as commercial conditions permit, the whole plant will be operated. With each cell taking 1,000 amperes at an e.m.f. of 5 volts, the 120 cells are calculated to yield 9 tons 241 lbs. bleach, and 4 tons 565 lbs. caustic soda per day. This output would nearly meet the present Canadian demand for these products.

Discussion.—**Rosebrugh** pointed out that the theoretical decomposing value of NaCl in aqueous solution with a mercury kathode was 4·06 volts, and that the counter e.m.f. produced by the decomposition of the resultant sodium amalgam was lost in the Rhodin cell. **Lang** drew attention to the fact that all electrolytic processes yield more chlorine per ton of caustic alkali than the old Le Blanc process, and that the difficulty in disposing of the bleaching powder produced would check their growth and development. J. B. C. K.

1930. *The Acker Electrolytic Alkali Process.* **C. P. Townsend.** (Elect. World and Engineer, 39. pp. 585–587, April 5, 1902.)—This is an illustrated article describing the Acker fusion process as operated at Niagara Falls with 325 h.p. After referring to the earlier attempts of Rogers, Borchers, Vautin, and Hulin to solve the problem presented by the electrolysis of fused salt with a kathode of molten lead, the author gives details of the Acker cell. [See Abstract No. 142 (1902).] The anodes, of which there are four in each furnace or pot, are of graphitised carbon, and are made by the Acheson

Company. Each anode has a working face 7½ in. × 14 in., and carries a current of 2,000 amperes.

The furnaces are lined with magnesite blocks, set without cement; the molten salt penetrates the joints, and, on solidifying, acts as binding material. The plant at Niagara now comprises forty-five furnaces, and eleven more are provided for. The energy is supplied by the Niagara Falls Hydraulic Power Company in the form of an 8,000-ampere current at 300 volts, and is transmitted to the alkali works by bare aluminium cables.

Each furnace requires an e.m.f. of 7 volts, and with a current of 8,000 amperes at this voltage, it absorbs 75 e.h.p. The average production of anyhydrous caustic soda per day under these conditions is 581 lbs. Settling is required, but no boiling down, to prepare this caustic for the market.

The output represented by the above figures is equivalent to a current efficiency of 93 per cent., and to an energy efficiency of 55 per cent. Owing to the higher e.m.f. theoretically required to work the fusion process this latter efficiency cannot be usefully compared with the energy efficiency of 52·3 per cent. given for the Castner-Kellner alkali process. The works of the Acker Process Company at Niagara Falls were started in December, 1900, and have been in continuous operation since that date, with the exception of one week's stoppage, owing to fire in the power-house.

J. B. C. K.

1931. *Manufacture of Barium Compounds in the Electric Furnace.* **C. B. Jacobs.** (Soc. Chem. Ind., Journ. 21. pp. 391–392; Discussion, p. 392, March 31, 1902.)—In the older methods of converting barytes into soluble barium compounds, the $BaSO_4$ is reduced to BaS by heating with coal or coke in a retort furnace; in this way, from 65 per cent. to 75 per cent. of the available sulphate is obtained as soluble sulphide, which is then converted into the other soluble barium salts. According to the patented process of the United Barium Company, Niagara Falls, N.Y., barytes is reduced in the electric furnace, and 97 per cent. to 99 per cent. of the sulphate obtained in a soluble form. The reaction on which the process is based is as follows:—

$$3BaSO_4 + BaS = 4BaO + 4SO_2.$$

This takes place so completely, on fusion in the electric furnace, that the product contains not more than 2 per cent. to 3 per cent. of unaltered $BaSO_4$, and frequently not more than 1 per cent. Owing to the high temperatures used, it is necessary to employ a carbon-lined furnace, with the result that enough of the $BaSO_4$ is reduced to BaS to destroy the equilibrium of the above reaction. In actual practice it has been found more economical to mix ground barytes and coke in equal molecular proportions. On heating the mixture, the following reaction takes place:—

$$4BaSO_4 + 4C = 3BaSO_4 + BaS + 4CO.$$

The resulting $BaSO_4$ and BaS then react according to the first-mentioned equation—

$$3BaSO_4 + BaS = 4BaO + 4SO_2.$$

The furnaces used are a new type of continuous electric furnace; they are tapped periodically, similarly to an iron blast furnace; the maximum power consumption is 500 kilowatts, and the maximum output 8 tons of furnace product per twenty-four hours. The product is dissolved in hot water, and the insoluble impurities filtered off. The solution deposits crystals of $Ba(OH)_2 + 8H_2O$; these are washed free from sulphydrate by spraying with cold water, dried and melted. The resulting crystallised barium hydrate contains less than 1 per cent. of impurities. The chief uses of the hydrate are in the white pigment and dry-colour trades, purification of water for industrial purposes, and in the recovery of sugar from beet sugar molasses. A new white pigment, derived from the hydrate, is said to be superior to "blanc fixe" or ground barytes in covering power, but its composition is not given. W. C. B.

REFERENCES.

1932. *Liquefaction of Gaseous Mixtures.* **F. Caubet.** (Zeitschr. Phys. Chem. 40. pp. 257-367, March 29, 1902. From the French.)—In this paper the author gives an account of the present state of the theory of the subject, and of his own experimental work on the three groups of mixtures, carbon dioxide and sulphur dioxide, carbon dioxide and methyl chloride, methyl chloride and sulphur dioxide [see Abstracts Nos. 843 and 2004 (1900) and No. 910 (1901)], of the apparatus employed, and the degree of accuracy of the observations. W. E. T.

1933. *Physico-Chemical Studies of Tin. VII.* **E. Cohen.** (Konink. Akad. Wetensch. Amsterdam, Versl. 9. pp. 438–439, 1902.)—This article is a continuation of previous researches by the same author. A striking case of zinc corrosion is recorded, and details of former investigations are given. [See also Abstract No. 1563 (1901).] A. G.

1934. *Nomenclature of Metallography.* (Iron and Steel Institute, Journ. pp. 1–28, May, 1902.)—This is a most valuable glossary, drawn up by an international committee appointed by the Council of the Institute, in English, French, and German, in the hope that it will tend to promote the unification of terms, the simplification of those used, and the elimination of many of them. G. W. DE T.

1935. *Resistance and Viscosity.* **G. Gouré de Villemontée.** (International Physical Congress at Paris, Report, 4. pp. 84–102, 1900–1901.)—This paper gives an account of the experimental work which has been carried out in order to investigate the connection between the electric resistance of a saline solution and its viscosity —work originally aimed at the verification of Wiedemann's law, but now at the determination of the state of ionisation of solutions. W. E. T.

1936. *Electrochemical Polarisation.* **C. J. Reed.** (Frank. Inst., Journ. 153. pp. 259–268, April, 1902.)—This is a general discussion of the various definitions usually given of polarisation, which the author regards simply as a progressive change, due to the progressive exhaustion of the reagents. W. R. C.

1937. *Electrical Energy Direct from Coal.* **J. Wright.** (Cassier, 21. pp. 465–472, April, 1902.)

1938. *Manufacture of Parabolic Reflectors by Electro-chemical Methods.* **C. Rost.** (Elektrochem. Zeitschr. 8. pp. 263–272, March, 1902.)—A short historical summary of work done in this field, with a detailed account of the Cowper-Coles process for the manufacture of Palladium reflectors, previously described in various English papers. O. J. S.

STEAM PLANT, GAS AND OIL ENGINES.

STEAM PLANT.

1939. *Balancing of Engines.* **W. E. Dalby.** (Mech. Eng. 9. pp. 731–736, May 31, 1902. Paper read before the Institution of Naval Architects.)—This is a sequel to the author's previous papers on balancing of engines, and deals with the questions of the increase of weight of the moving parts of engines of the usual types when masses are added to neutralise the unbalanced forces and couples, the change of weight introduced when the conditions of balance are satisfied in the original design so that no balance weights are necessary, and the changes in the form of the crank effort diagram to be expected when the crank angles are set to satisfy the conditions of balancing. Five types of triple-expansion engines are considered. A being a three-cylinder engine with cranks at 120°, B, C and D, four-cylinder engines with cranks at right angles, but in various sequences, and E a four-cylinder engine of the Yarrow-Schlick-Tweedy type, where the four cranks are set so as to balance among themselves. The necessary weight of moving parts is given in detail, the total being 9 tons for type A, 9·93 tons for B, C or D, and 10·27 tons for type E, for engines of the same power of 1,750 i.h.p. at 90 r.p.m. Of these, however, type E is balanced as it stands, while in the others there are large unbalanced forces and couples; in order to balance these as well as possible, additional weights would be required varying from 52 per cent. in type A to 15 per cent. in type C. Detailed diagrams of the unbalancing forces and of the crank efforts (calculated from the cards and allowing for inertia) are given. In conclusion, the author states that type E stands alone in having the unbalanced forces and couples in both vertical and horizontal planes practically *nil*, since in the other types the addition of masses to produce a balance in the vertical plane tends to increase the want of balance in the horizontal plane; and that the crank effort from this type can be made as uniform as that from any other four-cylinder type. [See also Abstract No. 2243 (1901).] H. R. C.

1940. *Speed Variations and Relative Angular Displacements in Prime Movers.* **F. Klönne.** (Elektrotechn. Zeitschr. 23. pp. 287–292, April 3, 1902.)—The author points out that in the case of prime movers required for driving alternators intended to run in parallel, it is frequently specified that the speed variation shall not exceed a certain limit. This can hardly be regarded as satisfactory, since what is *primarily* of importance in parallel running is relative angular displacement of the generator armatures with respect to the field-poles, and not mere speed variations. It is true that the latter are the cause of the former, but the relation connecting the two is by no means simple, and depends on the way in which the working strokes of the engine follow each other. The author investigates this relation by a graphical method, assuming that the crank-effort diagram of the prime mover is given, and shows how to calculate the moment of inertia of the rotating part in order that its angular displacement (*i.e.*, its maximum displacement from the position of an assumed uniform speed) may not exceed a given limit; this limit is stated to be taken as ± 8° of phase-difference by a well-known firm. A number of numerical examples are worked out in illustration of the author's theory. A. H.

1941. *Steady Running of Steam-engines.* **van der Stegen.** (Soc. Belge Elect., Bull. 19. pp. 14–42; Discussion, pp. 42–46, Jan., 1902.—In this paper the author divides into four classes the irregularities to which the running of a steam-engine is subject: (1) Cyclical variation of speed per revolution, produced in reciprocating engines by the periodic variation in the crank effort. This irregularity is limited solely by the moment of inertia of the flywheel, the action of the governor having no effect upon it. (2) Irregularity due to want of isochronism in the governor. (3) To want of sensitiveness in the governor, and (4) to inertia and instability of the governor. In certain cases these two last factors may be cumulative in their effects. Taking these different causes of irregular running in turn, the author first alludes to the well-known method by which, from the curves of tangential crank effort and of resistances, the maximum variation of kinetic energy of the flywheel, and consequently of speed, may be deduced. In the case of central station polyphase plants this method is insufficient, as it is not only the variations of speed, but the lag or lead of the flywheel with respect to the mean position it would assume at uniform speed, which is important. In this connection the author discusses the "coefficient of regularity" [see Abstracts Nos. 568, 940, and 942 (1902)], coming to the conclusion that any alteration of the accepted definition of this is at present inadvisable. The curve of periodic displacement is shown to be deducible from that of velocity by simple integration; as regards the question of the base-line from which the ordinates of the displacement curve should be measured, this ought to be the position assumed by an alternator running in perfect coincidence of phase on an infinite network. To determine this by analysis is a matter of some difficulty, but it will be very near the truth if the base is so chosen that the integral of the oscillation curve is zero; this is to assume that the synchronising torque is equivalent to an elastic coupling, the pull of which is proportional to the angular displacement. This is better than assuming that the displacement is one-half of the total oscillation, which is only true when the curves are perfectly sinoidal. Coming to the practical question, the engine builder has to determine the relative oscillations of the flywheel, not as they would be if only the inertia of the flywheel, the steady load, and the crank effort were taken into account, but as they are affected by magnetic actions brought into play by the displacements themselves. In this connection the conclusion of Boucherot is referred to, namely, that in a single-cylinder engine, when the diagram of crank effort approaches a true sinoidal curve, the displacements are always *increased* by the synchronising currents, and an explanation is given of this apparently paradoxical result. If in such a case the relative oscillation period of the alternator under the action of the synchronising couple coincides with the periodic fluctuations of the crank effort, "electromagnetic resonance" is set up and parallel running becomes impossible; even if this synchronism does not exist for the fundamental vibrations, it may do so in the case of the harmonics, with the result of increasing the oscillations to a dangerous extent. With multiple-crank engines, the curve of oscillations generally deviates considerably from the sinoidal form, and there is less danger of resonance. With machines driven by belts the effect is less marked than in the case of direct-driven plants; but even here it may be serious, as the elasticity of the belt cannot accommodate itself to too great variations. An interesting parallel (purely mechanical) of electro-mechanical resonance is given where a two-crank engine drove a main shaft by toothed gearing. The two ends of the shaft drove, by belting, two distinct sets of machinery, and it was found that the coefficient of regularity of the engine being about 1 per cent., while at one end of the shaft the irregularity was less than this, as is usually the case, at the other end it was greatly accentuated, the probable cause being the thrashing of a belt in synchronism with the impulses of the engine. The evil was cured by giving different admissions to the two cylinders, thus rendering the impulses irregular, and destroying the synchronism with the beats of the belt. Discussing the remedies for electro-mechanical resonance, it is pointed out that multiplication of cranks, and their arrangement at suitable angles, is desirable in the case of poly-cylindrical engines; two single-cylinder engines coupled are more regular than a single unit of twice the power of either, and similarly with compound tandem engines. The best angle between the cranks for two-cylinder engines is usually not 90°, but 100° or 110°; the reason being that the mean impulse in the larger cylinder usually occurs at a point further removed from the dead centre than in the case of the high-pressure cylinder; the best angle can only be determined by trial. With two-crank compound engines the regularity varies considerably with the load, since the division of load between the cylinders is different at different loads, particularly with a fixed cut-off on the high-pressure cylinder. Reference is made to an engine of 10,000 h.p. by the American firm of Allis, in which with only two cranks there are eight dead-points and eight impulses per revolution. This is effected by arranging the four cylinders, two on each crank, with the two high-pressure cylinders horizontal and the two low-pressure vertical: the cranks are set at 135°. The result is an almost perfectly regular turning moment. The inertia of the reciprocating parts is of considerable importance with the high speeds now common. The evil may be counteracted to some extent by weighting the cross-head. Inequality in the admission is a remedy not to be recommended from the point of view of economy of steam consumption. It is important to avoid too great inequalities between the admissions at the two dead-points at different loads. These inequalities, arising from the obliquity of the connecting-rod, can be got rid of by certain compensating devices. Three diagrams are given, showing in the case of a pair of coupled tandems the curves of speed and displacement: (1) with the weights (crank and half the connecting-rod) counterbalanced, (2) with these weights not counterbalanced, and (3) with a resistance chosen so as to give the greatest possible regularity. Comparing the diagrams, the most unfavourable conditions for regularity is seen to be the first, with the weights counterbalanced. A weight of 200 or 300 kg. on the rim of an alternator of not less than 40 tons would be sufficient to give the best results from the point of view of regularity, though such a method has disadvantages with regard to starting and stopping. This part of the paper concludes with a reference to apparatus which has been designed to measure cyclical variation in speed and flywheel displacement, a brief description being given of Cornu's arrangement (see Abstract No. 944 [1902]). (2) *Irregularity due to want of isochronism in the governor.*—A perfectly isochronous governor of the ordinary type would be inadmissible; but it is desirable to get as near to it as may be without increasing to an undue extent the disadvantages which attend certain ways of doing this. Thus if it attempted to restrict the range of the sliding sleeve, the power of the governor is reduced; if the range is preserved, but the dimensions of the governor are increased, inertia plays too great a part, and the sensitiveness is reduced. An arrangement is described by which, with the help of an auxiliary electro-motor, almost perfect isochronism may be secured, but it has the disadvantage of not acting *directly* on the governor. Moreover, too great a degree of isochronism introduces difficulties into parallel running in polyphase stations, as the slightest mechanical disturbance of the governors, owing to their inertia and the resulting instability, deranges the steam admission, causing reciprocal action between the alternators and large synchronising currents. For the operation of paralleling alternators it is usually necessary to be able to modify the speed by an adjustment of the governors, which is generally done by moving a weight either by hand, or, in some cases, by the switch-room attendant with the aid of a small electromotor; two methods of doing this are described. (3) *Want of sensitiveness in the governor.*—"Sensitiveness" is defined as the property in virtue of which the governor seeks to occupy at every instant the position of equilibrium corresponding exactly to the speed of rotation of the engine at that instant. Inertia and friction are the causes which make against sensitiveness; hence valves with trip-gear, by allowing these to be reduced to a minimum, conduce to sensitiveness in the governor. (4) *Inertia and instability.*—It is shown how these causes tend to produce hunting, with its attendant evils as regards parallel running; the question of limiting these oscillations, both as regards period and amplitude, is one best decided by experiment. With a governor of given type and dimensions, on a given engine, the most important way of increasing the stability is by the addition of an oil-brake or dashpot, the *rationale* of whose working is described. Lately these have been made with special valves by which the braking action is diminished in the case of very sudden variations of load; when the governor has nearly attained its position of equilibrium the valves close automatically, and the governor comes slowly to its final position. But while rendering the governor dead-beat the dashpot does not cure, but rather accentuates any sluggishness. In this connection another function of the flywheel is referred to, that, namely, of reducing oscillations due to the governor, and it is shown how the moment of inertia which the flywheel ought to have in order to annul these oscillations may be calculated if the time taken by the governor in passing from one position to the other is known; and it is explained how in high-speed engines a flywheel which may be sufficiently heavy to give the required regularity per revolution may be too light to prevent hunting of the governor due to change of load. Designers should therefore calculate the moment of inertia required for each purpose and adopt the highest value—multiplication of cranks, while providing a partial remedy for the first evil, has no effect on the latter. A discussion followed the reading of the paper, which is illustrated by curves and diagrams. B. P. S.

1942. *Engine Requirements for the Parallel Operation of Alternators.* **E. M. Tingley.** (Elect. Rev. N.Y. 40. pp. 730–731, May 31, 1902.)—The author in this paper gives the text of, and discusses the points raised in, a specification which the Westinghouse Company have issued for the guidance of engine builders, and which crystallises the results of their experience in regard to the points to which the latter should pay special attention when designing engines to drive alternators in parallel. The four headings included in the specification are (*a*) *The Governors,* which should not have any tendency to cause surging of load between one engine and another, or to maintain or increase such surgings if otherwise set up. In this connection the author discusses the general question of the "pumping" of alternators in parallel, or of synchronous motors and rotary converters fed from them, showing how the governors may in certain cases accentuate the evil by resonance. Usually, increased flywheel action decreases the tendency to pumping, but in certain cases, by increasing the resonant effect, this may have the opposite result.

(*b*) ***Flywheel displacement.***—The total variation, positive *plus* negative, of the position occupied by any radius of the flywheel from that which it would occupy if the rotation were absolutely uniform, should not exceed 3° for a two-pole machine, 1·5° for a four-pole, 1° for a six-pole, and so on; or generally, one-sixtieth of the pitch angle of two consecutive poles. This limit is not really too small; some authorities give a value one-sixth less than this. (*c*) ***Percentage drop of speed*** with load should be the same for all engines which have to run in parallel. This condition is necessary to ensure that each alternator should take up its proper share of the load. (*d*) ***Governors*** should be adjustable while running. This is advisable, as the engine governors will usually vary in their own adjustment, and it is necessary to correct this from time to time so that the load may be properly divided; also with this adjustment the load is much more easily transferred for purposes of synchronising or separating machines. [See also preceding Abstract.] B. P. S.

1943. *Straining Forces on Crank-Shafts.* **S. Dunkerley.** (Engineering, 73. pp. 402–403 and 426–428, March 28; 454–458, April 4; and pp. 491–494, April 11, 1902. Paper read before the Institution of Naval Architects.)—The author investigates all the straining actions on a crank-shaft; the different twisting moments in the different portions, and the bending (allowing for the continuity of the shaft at the bearings by means of the theorem of three moments). An actual case of a crank-shaft of a four-cylinder triple expansion marine engine is worked out in full. The cranks of the engine were arranged at the angles necessary to balance the reciprocating parts. The forces are estimated from indicator cards taken when the engine was working at 10,300 h.p. Diagrams of the turning moments (corrected for inertia and weight of the reciprocating parts) and of the bending moments are given, and the diagrams of equivalent twisting moments and tables of maximum stresses are deduced. The engine considered had one low-pressure cylinder in front of the high pressure, and a remarkable feature of the results is that the greatest equivalent twisting moment occurs at the high-pressure crank, and not at the after low pressure as would be naturally expected. H. R. C.

1944. *Liquid Fuel for Steam Purposes.* **J. S. S. Brame.** (Nature, 66. pp. 186–188, June 19, 1902.)—This paper recounts the general advantages of oil for fuel [see Abstracts Nos. 1547 (1900), 546, 1375 (1901), and 950 (1902)] quotes Aydon's classification of the methods of using it, and refers specially to its use on railways, notably the Grazi-Tzaritzin Railway of Russia and the Great Eastern of England, and to some instances of its use in the Mercantile Marine. [See Abstract No. 1766 (1902).]

With regard to the calorific value of oil, the author remarks upon the omission, from calculations of the theoretical heat value, of allowance for the physical condition of the fuel. [See also Journ. Soc. Chem. Indus. vol. vii. pp. 195–200.] F. J. R.

1945. *Liquid Fuel.* **R. G. Paddock.** (Mech. Eng. 9. pp. 842–843, June 21, and pp. 875–876, June 28, 1902. Paper read before the Technical Society of the Pacific Coast.)—The author reviews the history of the subject from its commencement in the United States in 1861 or 1862, referring to the plans of Shaw and Linnton, Foote, Dorset and Blyth, Thwaite and others in America and Britain; Leng, Artemeiv, Karapetov, and Urquhart in Russia, and experiments in France, Italy, and Germany. He decides against efforts to convert the oil into gas before combustion, and in favour of the spraying system combined with preliminary settling of the oil, to separate water from it, and heating of the oil. The most recent systems introduced into steamships are those of Flannery-Boyd and of Orde, the latter being the more efficient. In this system the oil is passed through a settling tank, from which it is pumped to the burners under a pressure of 60 lbs. Before reaching the burners, it is heated, principally by waste heat, to a temperature just below its boiling-point, and on emerging from the inner tube of the burner, it is met by steam and air heated to 600° F., or more if needed, and is wholly converted into vapour. With Borneo oil of 18,800 B.Th.U. an evaporation of 16 lbs. has been obtained, the waste gases showing 13·2 per cent. CO_2, 3·6 per cent. oxygen, and 83·2 per cent. nitrogen. The introduction of the Körting system in steamers of the Hamburg-American line is also referred to. The metallurgical furnaces in Pennsylvania have several years' record of successful use of oil for reheating, and even for open hearth steel-making. The furnaces have to be carefully designed according to the degree of heat wanted, and for welding, the use of steam for spraying is bad. With superheated steam, however, iron may be melted without undue loss by oxidation. Regarding the characteristics of different oils the following facts are given :—

	California.	Russia.	Texas.	Borneo.
Gravity..................	16° B.	—	25°–30° B.	32° B.
Flash point............	275°–300° F.	—	135°–150° F.	200°–220° F.
Mean boiling-point	500° F.	—	170°–190° F.	390°–410° F.
Thermal value from analysis and calorimeter test	18,300 to 18,800 B.Th.U.	19,000 to 20,000 B.Th.U.	18,500 to 19,000 B.Th.U.	18,800 to 19,000 B.Th.U.

Carefully conducted evaporative tests gave :—(1) Vaporisation system, Borneo oil 32° B. theoretically possible from and at 212° F. 19·46 lbs. Highest net result 16 lbs. (2) Vaporisation system, West Virginia oil 40° B. Theoretical 21·7 lbs. Net 16·5 lbs. (3) Steam spraying system, warm air for combustion. Texas oil 25° B. Theoretical 19·77 lbs. Highest net 15·16 lbs. Assuming 18,600 B.Th.U. average for California oil 16° B. or a theoretical of 19·25 lbs. ; 14·8 lbs. with spray systems and 15·7 lbs. with vaporisation is as much as can be expected. [See also preceding Abstract.]

F. J. R.

1946. *Separation of Oil from Condensed Steam.* **J. R. Bibbins.** (Eng News, 47. pp. 406–409, May 22, 1902. Paper read before the Detroit Engineering Society, Jan. 24, 1902.)—Oil is carried from engine cylinders and valves through condensers in the form of free oil, and also in that of an emulsion with water. In order to arrive at the best method of separating it in both forms from the water to be returned to the boiler, extensive experiments were carried out at Station "C" of the Detroit Edison Company with condensing plant consisting of a 1,600-sq. ft. Worthington surface condenser attached to two tandem compound engines of 400 h.p. When the water of condensation was sent through a coke filter, consisting of a cylinder 14 in. diameter and 10 ft. high filled with coke of pea-nut size, except for a short length at either end which formed settling chambers, oil gradually accumulated on the sides of the cylinder and passed into the boilers. The emulsion was not stopped by the filter. It was found that a temperature of 265° to 280° F. caused the separation of the oil from the water, but 215° F. produced no result. Submitting the emulsion to pressure, vacuum and aeration produced no effect. Collection of samples of steam from the exhaust-pipe at different depths showed that no free oil was there, and emulsion occurred only at or near the bottom of the pipe—the exhaust steam at the top of the pipe being pure steam. A steam trap at the lower end of the receiver between high- and low-pressure cylinders caught all the free oil. It is supposed, however, that either the heat of the dry surfaces of the exhaust-pipe or some action in the condenser may cause separation of oil and water and account for the free oil found in the filter. Chemical tests showed that precipitation of the oil by means of calcium compounds such as powdered chalk or marl was rapid and satisfactory. Fuller's earth also acted efficiently, but more slowly. Different designs of oil separators such as those of Baum, Bundy, and Cochrane are described, and the Bundy automatic trap is commended for use in conjunction with Bundy and Cochrane separators in a vacuum system. The author recommends that all oily drips from engines, pumps, reheaters, and separate traps should be separately purified; and some short notes on the purification of feed-water are included in the paper. Illustrations of the filter and of the apparatus used in the experiments accompany the paper. F. J. R.

GAS AND OIL ENGINES.

1947. *Algrin Motor.* **L. Fournier.** (Locomotion Automobile, 9. pp. 341–343, May 29, 1902.)—This is an alcohol engine, having three cylinders, two power cylinders, and one compressor. The stroke of the compressor piston, and consequently, the quantity of compressed gas admitted to a power cylinder, can be varied by hand while the engine is running. In this manner the speed of the engine may be kept constant while the power is varied over a wide range. C. R. D'E.

AUTOMOBILISM.[1]

1948. *Peugeot Petrol Delivery Van.* (Locomotion Automobile, 9. pp. 326–328, May 22, 1902.)—This vehicle has a tubular steel underframe carrying a double-cylinder horizontal internal combustion engine of 7 b.h.p. at 800 r.p.m. at its front end. The power is transmitted through a cone friction clutch and roller chain drive to the first motion shaft of the change-speed gear, which gives four forward speeds and one reverse by means of sliding spur wheels. The second motion shaft of the change gear is also the differential shaft, and from its ends the power is delivered to the rear road wheels by means of independent roller chains. The road wheels are of equal diameter front and back, and have wood spokes. Solid rubber tyres are employed. Several views of the chassis are given. C. R. D'E.

1949. *G. Richard Light Petrol Car.* (France Automobile, 7. pp. 281–283, May 3, 1902.)—The latest type of this make of petrol car is described. It has a tubular underframe spring by longitudinal plate springs from the front and rear axles. The engine, a double-cylinder vertical developing 12 b.h.p. at 1,200 r.p.m., is mounted towards the front of the frame and covered by a bonnet. The power is transmitted through a cone friction clutch to the spur-wheel change-speed gear, and thence, by a flexible tail-shaft and bevel drive, to the live rear axle. The change gear is so arranged that a through drive from engine to bevels is obtained on the highest speed. [See also Abstracts Nos. 714 and 1910 (1900).] C. R. D'E.

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[1] Electric Automobiles are described in the Section dealing with Electric Traction.

1950. *Gladiator Light Car.* **M. Gerald.** (France Automobile, 7. pp. 316–318, May 17, and p. 330, May 24, 1902.)—The underframe in this car is of wood lined with steel plate. The engine, which is of the "Aster" single- or double-cylinder type, according to the power of the car, is mounted towards the front end of the main frame, and together with the change-gear box, is attached to a subsidiary angle steel frame suspended from the wood frame. The power is transmitted through a cone friction clutch to the change-speed gear, which gives three forward speeds and one reverse, by sliding spur wheels on the Panhard system. From the second motion shaft of the change gear the power is transmitted by a bevel drive to the differential cross-shaft, and thence by independent chain drives to the rear road wheels. C. R. D'E.

1951. *Cuyer Dirigible Balloon.* **L. Fournier.** (Locomotion Automobile, 9. pp. 294–296, May 8, 1902.)—This apparatus consists of three principal parts. A platform carrying the motive mechanism, a pair of semi-cigar shaped balloons supporting the platform, and above these a large horizontal, and two smaller vertical aeroplanes. Along the longitudinal centre line of the horizontal aeroplane lies a shaft driven from the engine on the platform below, and carrying at its ends double blade propellers. In order to cause the machine to rise, the large aeroplane may be inclined slightly to the horizontal. C. R. D'E.

REFERENCES.

1952. *Feed-heaters Commercially Rated.* **H. L. Hepburn.** (Power, N.Y. 22. pp. 11–13, April, 1902.)—Principally a comparison between Poole's and Whitham's formulæ, as regards the dimensions worked out by their use. [See also Abstracts Nos. 758, 759, and 1176 (1902).] F. J. R.

1953. *Comparison of Steam and Gas Engines.* **A. Witz.** (Écl. Électr. 30. pp. 5–16, Jan. 4, and pp. 41–54, Jan. 11, 1902.)—This paper consists chiefly of a collection of valuable data regarding the efficiency of boilers, steam engines, gas producers, gas engines, and oil motors. The author considers that there is a great future for gas producers combined with gas engines. The paper is exclusively technical, and does not deal with the cost of fuel, or the commercial features of the various items. E. H. C.-H.

1954. *White Steam Carriage.* (Automobile Rev. 6. pp. 93–94, May, 1902.)—The paper gives some further details of the engine and furnace with illustrations. [See also Abstract No. 1197 (1902).] C. R. D'E.

1955. *Digest of Kerosene Burner Patents.* **F. W. Barker.** (Horseless Age, 9. pp. 650–655, May 28, 1902.)

1956. *Petroleum Vapour Burners.* **J. S. V. Bickford.** (Horseless Age, 9. pp. 632–635, May 28, 1902.)—The object of the article is to give the principles on which petroleum apparatus may be designed. C. C.

GENERAL ELECTRICAL ENGINEERING.

1957. *Tests of Accumulator Endurance.* (Résumé des Essais d'Endurance, Paris, pp. 1–16, 1902.)—These are the results of a series of tests instituted by the Ministère de la Marine. Eleven manufacturers submitted cells—all of French make—and the total number tested was 21. The following procedure was adopted. The cells were all coupled in series, and after a preliminary charge, were discharged at 660 amperes, about their one-hour rate. The discharge of the whole of the cells was discontinued when any one of them fell to 1·65 volts. They were then all recharged at 330 amperes, receiving 50 per cent. more ampere-hours than had been given out on the previous discharge. Two discharges and recharges were effected every day except Sundays, when the cells were left at rest. Any cell that from any cause whatever fell to 1·65 volts in less than half an hour, was disqualified from officially continuing to take part in the contest, and even if left in circuit, no further figures relating to it were recorded. In this way they were one by one eliminated. At 150 discharges (which was originally intended to be the limit of the tests), 11 still remained at work, but at 250 discharges all but 5 had been retired, and the trial was concluded, having extended from October 10, 1901, to March 17, 1902. Nothing was allowed to be done to the cells at any time so long as they kept up to the prescribed standard, except to tighten up connections, or add water or acid as their electrolyte might require. As each cell failed, it was examined and, if necessary, taken to pieces, and particulars are given of the cause of the failure. In many cases it appears to have been due to casual short-circuits, and not to a general breakdown. Hardly any details are furnished as to the design or construction of the different makes, or their weight. Eleven cells had both positives and negatives of the pasted type; nine had Planté type positives and pasted negatives; and one only had both positives and negatives of the Planté type. A sheet of curves is supplied showing the relative position of every cell throughout the tests. E. J. W.

1958. *Submarine Telephone Cables.* **C. E. Krarup.** (Elektrotechn. Zeitschr. 23. pp. 344–346, April 17, 1902.)—In this paper, some measurements of self-induction are described, which are a continuation of those made by Breisig [see Abstract No. 729 (1900)]. One feature of the present experiments is that lengths of wire or cable of 50 cm. only were employed instead of long lengths. Cables were measured in which each conductor was wound round with a separate layer of iron wire. The results showed the following: (1) Whilst in a cable without iron, or with an iron sheath common to all the conductors, the self-induction for single-conductor lines is greater than for double-conductor lines, the opposite is the case for cables with an iron sheath round each conductor. (2) The self-induction caused by the layer of iron increases in a higher proportion than the weight of the iron when the magnetic circuit is better closed. (3) The fine closely-wound wire of higher permeability is much more advantageous than bands in producing high self-induction. The results obtained are used in the well-known damping formula—

$$D = e^{\sqrt{\frac{Cp}{2}\left(\sqrt{R^2 + p^2L^2} - pL\right.}}$$

giving p (frequency) different values, so as to show the advantages of this form of cable. C. K. F.

1959. *Capacity of Polyphase Cables.* **A. della Riccia.** (Soc. Belge Élect., Bull. 19. pp. 318–326, May, 1902.)—In practice, the frequency is low enough to allow electrostatic equilibrium to set in at any instant of the cycle, and the ordinary law of electrostatics for a number of charged bodies holds. There are eight possible tests of capacity with a three-core lead-covered cable, thus—

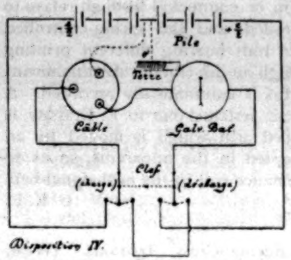

Fig. 1

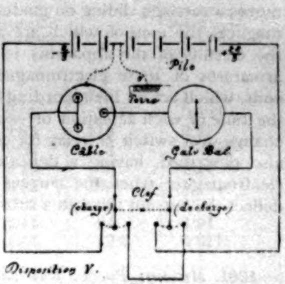

Fig. 2

No.	Conductor to be connected to one Pole.	Conductor to be insulated.	Conductor to be connected to the other Pole.	Expression for the Capacity.
I.	Sheath	2 Conductors	1 Conductor	$K_1 = \frac{R^2 + RS - 2S^2}{R + S}$
II.	Sheath	1 Conductor	2 Conductors	$K_2 = 2\frac{R^2 + RS - 2S^2}{R}$
III.	Sheath	None	3 Conductors	$K_3 = P = -3Q$
IV.	1 Conductor	Sheath and 1 Conductor	1 Conductor	$K_4 = \frac{1}{2}(R - S)$
V.	1 Conductor	Sheath	2 Conductors	$K_5 = \frac{2}{3}(R - S)$
VI.	Sheath and 1 Conductor	1 Conductor	1 Conductor	$K_6 = \frac{R^2 - S^2}{R}$
VII.	Sheath and 1 Conductor	None	2 Conductors	$K_7 = 2(R + S)$
VIII.	Sheath and Conductors	None	1 Conductor	$K_8 = R$

When P, Q, R, S are constants depending on the relative radii of (i.) the conductors, (ii.) the circle round which they are placed, (iii.) the inside of the lead sheath, Test IV. gives the relation: "The nominal capacity of any one of the two conductors is double the capacity between two conductors and the third when the sheath is insulated."

Test V. gives the relation: "The nominal capacity of any one of the three conductors is equal to 1½ times the capacity between one of the conductors and the two others, the sheath being insulated."

The figure shows the connections for the test. M. O'G.

1960. *Automatic Registering Apparatus.* **H. Fillunger.** (Zeitschr. Elektrotechn., Wien, 20. pp. 240–244; Discussion, p. 244, May 11, 1902.)—In this arrangement, which may be used as an indicator for railway signals, bells, or

rail-contacts, there is a drum which bears a recording band, and is rotated by clockwork so as to rotate once in fifteen minutes. From this drum there is driven a leading screw arranged parallel thereto and bearing a nut which moves a carriage sliding on guides. This carriage bears a number of electromagnets, the coils of which are arranged in or connected through relays to the circuits of the apparatus to be controlled, and the spring-controlled armatures of these electromagnets actuate rods bearing different printing ends, which act on the recording-band through an ink-ribbon. By this means the time of each actuation of each apparatus is automatically recorded. A change-over switch or relay for closed circuit systems, due to E. Krassny, is also described, having a delicately balanced arm which is moved by an electromagnet when the current is interrupted in the apparatus, so as to deflect the current through a substitute resistance coil to the next signal-bell.
C. K. F.

1961. *Missouri Pacific Railroad Shops, Baring Cross, Arkansas.* (West. Electn. 30. pp. 417–419, June 14, 1902.)—These workshops are driven by 250-volt motors, including seven of 30 h.p., two of 20 h.p., and one of 3 h.p. These motors, aggregating 253 h.p., drive about 100 different tools, the total individual h.p. of which is over 500. A diagram is given showing the current taken by a 30-h.p. motor, as the various machines driven by it are started in succession. W. H. S.

1962. *Impulse Water-Wheels.* **J. T. Farmer.** (Journal of Electricity, S.F. 12. pp. 32–39, Feb., 1902. Paper read before the Canadian Society of Engineers, Jan. 20, 1898.)—A description is given of a series of experiments on a small Pelton wheel at various heads and speeds, the greatest h.p. being about 7. The author gives a set of values for the theoretical efficiency, calculated by allowing for the loss at the jet and the inclination of the buckets to the radius of the wheel; the efficiencies realised fall short of the theoretical ones by from 15 to 25 per cent., the difference being chiefly attributable to splashing on the buckets. The actual efficiency of the wheel varied from 37·9 per cent. with a head of 235 ft., giving 1·7 h.p. at 276 r.p.m., with a nozzle 0·53 in. dia., to 70·8 per cent. with the same head, giving 6·9 h.p. at 756 r.p.m. with a nozzle 0·75 in. dia. H. R. C.

1963. *Aluminium.* **W. M. Morrison.** (Inst. Elect. Engin., Journ. 31. pp. 400–411; Discussion, pp. 411–419, Feb., 1902.)—The theoretical voltages required for the decomposition of various aluminium compounds are:—For aluminium fluoride, 4·0 volts; oxide, 2·8. volts; chloride, 2·3 volts; sulphide, 0·9 volts. The specific gravities of the materials present in the furnace are for commercial aluminium, solid, 2·66, fused, 2·54; for commercial Greenland cryolite, solid, 2·92, fused, 2·08; and for cryolite saturated with alumina, solid, 2·90, fused, 2·35. Hence it is only just possible for the aluminium set free to sink to the bottom or kathode of the furnace. Care is required to maintain the economical temperature without altering the relationship of the specific gravities. Impurities consist entirely of iron and silicon in proportions approximately as shown:—Silicon, 0·18 per cent.; iron, 0·26 per cent.; and aluminium 99·56 per cent. The production of the present year is 5,000 tons, or 100 times as much as thirteen years ago. The metals which aluminium is most likely to replace are copper and tin, the world's use of which last year was respectively 497,000 tons and 79,200 tons. The specific gravities, equivalent weights, and equivalent prices for equal volume of the common metals are shown below :—

Metal.	Specific gravity	Weight for equal volume.	Cost per ton.	Comparative cost of ingot metal for equal volume.
			£	
Aluminium	2·56	1	148	1
Zinc	7·00	2·73	17·5	0·323
Tin	7·30	2·85	115	2·21
Cast Iron	7·40	2·89	3	0·0586
Brass (50 per cent. alloy)	8·30	3·25	50	1·10
Nickel	8·50	3·32	196	4·40
Copper	8·63	3·37	66	1·51
Gun Metal	8·73	3·41	84	1·94
Lead	11·40	4·45	12·5	0·377

For equivalent volume aluminium weighs only 37 per cent. of the next lightest metal in common use, and that as regards cost only zinc, lead, and cast iron are lower. Its shrinkage in casting is high, as shown in the following table :—

SHRINKAGE OF CASTINGS.

Zinc	3125 inches in a foot	= 2·60 per cent.
Lead	3125 „ „	= 2·60 „
Aluminium	2031 „ „	= 1·69 „
Copper	1875 „ „	= 1·56 „
Brass	1580 „ „	= 1·32 „
Iron pipes	1250 „ „	= 1·04 „

COMPARATIVE FIGURES OF COPPER AND ALUMINIUM WIRE.

	Copper Wire.	Aluminium wire.
Specific gravity	8·93	2·65
Conductivity	100	61
Section for equal conductivity	1	1·64
Diameter „ „	1	1·28
Weight „ „	1	0·485
„ „ section	1	0·297
Tensile strength for equal section	1	0·46
„ „ „ conductivity	1	0·75

Out of 28 different joints for overhead wires the best is as follows :—The two ends of the wires are bent round each other, or simply butted together, they are then surrounded by a cigar-shaped mould in two halves, which are clamped together and molten aluminium run in at a hole in the top of the mould. The mould is then removed and the joint trimmed. Aluminium having a low melting-point, the metal required for this joint can easily be melted in a hand ladle on the fire of a portable forge. The 5,500 ft. of overhead line 0·38 in. in diameter have been in use for five years and have given no trouble. The author has taken the case of low-tension armoured lead-covered paper insulated cables, of the highest class, ready for laying directly in the ground, and found that with copper at 10d. per lb. aluminium wires insulated and sheathed in a similar manner of the same conductivity as copper (*i.e.*, 1·64 times the section) would have to be obtainable to equal the cost of the copper cables, at from 14·5d. to 16·5d. per lb. for sections from 1 to 0·2 sq. in. of copper. The lack of proportionality between the radial depth of insulation in cables and its dielectric strength was pointed out by Swinburne, and has been very fully dealt with by Mervyn O'Gorman, who has shown conclusively that for a given voltage there is a certain section of copper which gives the cheapest cable. Above this size the increase in price is proportional to the copper. Thus in one of O'Gorman's curves it is shown that for 20,000 volts and paper insulation with lead sheathing, 0·4 sq. in. is the section of copper which gives the cheapest cable. Suppose that 0·25 sq. in. of copper to be sufficient for the power to be transmitted, then, by substituting 0·4 sq. in. of aluminium for the copper we get a cable which fulfils the necessary conditions, and costs from £150 to £170 less per mile than the copper cable. The following table is important :—

No. S.W.G.	Dia. in inches.	Area in square inches.	Weight in lbs. per mile.		Length in feet per lb.		Resistancy per mile in ohms.	
			Aluminium.	Copper.	Aluminium.	Copper.	Aluminium.	Copper.
0000000	0·500	0·196	1,194	3,981	4·42	1·33	0·353	0·215
000000	0·464	0·169	1,018	3,426	5·18	1·56	0·410	0·250
00000	0·432	0·147	891·5	2,972	5·92	1·78	0·476	0·289
0000	0·400	0·126	764·4	2,547	6·91	2·07	0·554	0·337
000	0·372	0·109	661·1	2,204	7·99	2·47	0·642	0·390
00	0·348	0·0951	578·5	1,926	9·13	2·74	0·731	0·445
0	0·324	0·0824	507·8	1,671	10·40	3·16	0·840	0·513
1	0·300	0·0707	429·9	1,433	12·28	3·68	0·980	0·597
2	0·276	0·0598	363·7	1,212	14·52	4·37	1·16	0·707
3	0·252	0·0499	304·1	1,012	17·36	5·22	1·40	0·850
4	0·232	0·0423	253·3	855·6	20·85	6·17	1·64	1·00
5	0·212	0·0353	214·7	715·7	24·59	7·38	1·97	1·20
6	0·192	0·0290	176·1	587·0	29·99	8·99	2·40	1·46
7	0·176	0·0243	148·0	493·3	35·68	10·70	2·86	1·74
8	0·160	0·0201	126·3	507·5	41·79	12·96	3·45	2·10
9	0·144	0·0163	99·1	330·5	53·26	15·98	4·28	2·60
10	0·128	0·0129	79·5	260·9	66·44	20·23	5·38	3·28
11	0·116	0·0106	63·0	214·3	83·82	24·63	6·56	4·00
12	0·104	0·00849	48·7	172·3	108·4	30·64	8·20	4·98
13	0·092	0·00665	39·6	134·8	133·2	39·17	10·5	6·36
14	0·080	0·00503	31·4	101·4	168·0	52·09	13·9	8·42
15	0·072	0·00407	24·8	81·1	211·9	65·10	17·1	10·4
16	0·064	0·00322	19·8	64·9	267·2	81·38	21·7	13·2
17	0·056	0·00246	15·7	49·9	336·9	105·9	28·2	17·2
18	0·048	0·00181	10·9	36·5	482·6	144·7	38·4	23·4
19	0·040	0·00126	7·81	25·5	675·7	207·4	55·2	33·6
20	0·036	0·00102	6·20	20·6	851·8	255·9	68·1	41·6
21	0·032	0·000804	4·92	16·4	1,074	322·3	86·3	52·6
22	0·028	0·000616	3·73	12·5	1,414	423·1	113	68·6
23	0·024	0·000452	2·74	9·16	1,929	576·4	154	98·5
24	0·022	0·000380	2·45	7·70	2,154	685·7	182	111
25	0·020	0·000314	1·94	6·36	2,716	830·2	222	135
26	0·018	0·000254	1·54	5·14	3,425	1,027	272	166
27	0·0164	0·000211	1·22	4·28	4,318	1,234	328	200
28	0·0148	0·000172	1·03	3·49	5,106	1,514	403	246
29	0·0136	0·000145	0·884	2·95	5,974	1,796	478	291
30	0·0124	0·000121	0·730	2·44	7,233	2,164	576	351

Discussion.—**W. McWhirter** said that it would be advisable to decrease the distance between the poles where aluminium lines were erected, but, by the use of an aluminium alloy, the breaking weight could be increased by 38 per cent. with slight reduction in conductivity, and considerable use would probably be made of these alloys. **H. A. Mavor** gave an example of low cost of power production at about 0·093 pence per h.p. per hour for coal, wages, oil, and stores. (See paper read to the Institution of Engineers and Shipbuilders' in Scotland on March 22, 1898.) **H. J. Bubb** said the wiring of the outside arc lighting at the Glasgow Exhibition was entirely done with bare aluminium. A drop of 10 volts was to be the maximum, the lamps being arranged ten in series across mains at 510 volts. The aluminium wire was No. 8 S.W.G. wire for long circuits, or No. 7 for short circuits. Joints were avoided where possible, and where inevitable, a butt weld was made. The flame of a blow-lamp impinged on a firebrick, the two ends of the wire to be jointed, roughly cleaned with emery paper, were brought together in the flame so that one side was heated by the flame direct and the other by the flame reflected. At the instant of semi-fusion, which was easily noticed, the ends were pressed together, and the wire steadily removed from the flame and held until the metal had completely set. The lubricant in machining aluminium was half turpentine and half water; with this the metal could be machined with the same facility as brass. The harder alloys machined perfectly well dry. Bolts and studs should be chased, and not screwed in dies, and in cutting thread, a flow of lubricant should be kept on the work. For drawing through a die, horse-grease, tallow, or suet was recommended. **W. Murray Morrison** observed that the figure of £2 per i.h.p. per annum given by H. A. Mavor was surprisingly low, for the most economical steam engines now in use required very nearly 4 tons of coal per h.p. per annum working continuously at their highest efficiency. M. O'G.

1964. *Experimental Model Basin at Washington Navy Yard.* **J. A. McCrary.** (Elect. World and Engineer, 39. pp. 807–809, May 10, 1902.)—The basin is 40 ft. by 470 ft., and was built for determining by means of models the resistance to be overcome at the speeds at which the vessel is likely to move. A towing carriage spans the basin, running on tracks on either side, and weighing 25 tons. The motors driving the carriage have their fields constantly excited from a separate source, and their armatures supplied with current which is controlled by rheostats. The carriage tows the model through the basin, and as soon as the speed has become uniform, the recording drum of a mechanical dynamometer is thrown into action by means of a clutch, and thus the time, distance travelled, and resistance to motion of the model under the conditions of the test are recorded. A speed of 18 knots can be obtained. W. H. S.

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1965. *Accumulator "Etampé."* **J. Reyval.** (Écl. Électr. 31. pp. 168–170, May 3, 1902.)—A description of the processes of manufacturing the grids and electrodes of this cell, which are of the stamped sheet pasted type. E. J. W.

1966. *Electro-Pneumatic Control of a Sewage Reservoir.* (Electricity, N.Y. 22. pp. 288–290, May 28, 1902. From the Railway and Engineering Review.)—The Moon Island sewage reservoir in Boston is controlled by an application of the Westinghouse electro-pneumatic system, the various gates being operated at distances ranging up to 500 yards. The installation is fully described. W. H. S.

1967. *Education of the Electrical Engineer.* **W. Esty.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 771–780, May, 1902.)

GENERATORS, MOTORS, AND TRANSFORMERS.

1968. *Design of very High-Speed and very Low-Speed Machines.* **F. Niethammer.** (Elektrotechn. Zeitschr. 23. pp. 437–445, May 15, 1902. Paper read before the Elektrotechn., Verein, April 25, 1902.)—The author considers in detail the various difficulties which are encountered in designing generators and motors, both continuous and alternating, when the speed is either very high or very low. The normal range of speeds for various powers is given in the following table :—

Horse-power	4	10	40	100	200	300	500	700	900	1200	1500	2000
Usual Speed Limits	530 to 2200	400 to 1400	290 to 900	220 to 620	170 to 460	140 to 320	120 to 270	100 to 240	80 to 230	70 to 210	60 to 205	50 to 200

As regards the temperature limit, in the case of slow-speed machines it is desirable to use short armatures of large diameter, in order to obtain a large cooling surface and free circulation of air ; the author emphasises the importance of providing a sufficient number of ventilating ducts, and states that experiments made with armatures whose ventilating ducts had been purposely stopped up showed an enormous increase in the temperature rise. Abnormally high speeds are, of course, highly favourable both as regards heating and efficiency, and in this respect present no difficulties. As a result of measurements made on hundreds of machines, the author states that if an attempt be made to calculate the temperature rise t from a formula of the type $t = Cw/s$, where $w =$ total watts dissipated, and $s =$ total radiating surface, then the value of the coefficient C varies from 200 to 1,400 *in the case of open-type machines*, rendering any calculation of the probable rise quite hopeless; but in the case of *enclosed* motors, the range of variation of C is only from 600 to 900, and reliable results may be obtained. The consideration of the temperature limit leads the author to institute a comparison between a 200-h.p. continuous-current motor and a three-phase induction motor of the same power, the efficiency at full load being in each case 94 per cent. The following table gives the distribution of losses at full load and at starting, the starting torque being taken as three times the full-load running torque :—

	Cont. Current Motor running at 200 h.p., in h.p.	Cont. Current Motor at starting with 3-fold torque, in h.p.	3-Phase Induction Motor running at 200 h.p. in h.p.	3-Phase Motor at starting with 3-fold torque in h.p.
Armature copper (rotor) loss	3½	22	3½	43
Field copper (stator) loss...............	3½	22	3½	12
Iron loss	5	0	5	43
Total loss..........................	12	44	12	98

Even in the case of the continuous-current motor there is great difficulty in keeping the temperature rise within reasonable limits when starting is frequent; the difficulty in the case of the three-phase motor is, as the table shows, enormously greater. According to the author, this shows the soundness of the system of rotary converter working advocated by American engineers, and the wisdom of the decision arrived at in connection with the Inner Circle line. The problem of sparkless commutation in relation to speed is next dealt with. The author advocates the use of lap windings with equalising rings in preference to multiple wave windings. The importance of the "reactance voltage" is pointed out, and detailed formulæ given for calculating it in various cases. Abnormally slow-speed machines present no difficulty as regards sparkless commutation, whereas abnormally high-speed machines are extremely difficult to design satisfactorily from this point of view. A purely mechanical difficulty arises in the case of abnormally high-speed machines (such as steam turbine-driven generators), on account of the fact that when the maximum permissible diameters of armature and commutator (determined by the greatest safe centrifugal stress) have been reached, an increase of output can only be obtained by increasing the length of the armature, and a point is reached beyond which the armature core stampings cannot be satisfactorily held in place on account of the excessive length of the clamping bolts. Various other mechanical difficulties, with special reference to three-phase generators and induction motors, are finally dealt with. A. H.

1969. *American Practice in Dynamo Design.* **T. Square.** (Elect. Engin. 29. pp. 734-736, May 23, 1902.)—The author gives the flux densities in American machines as follows: Core, 13,000 to 18,000 lines per sq. cm.; teeth, 18,000 to 21,000 lines per sq. cm.; poles, 13,000 to 16,000 lines per sq. cm.; yoke, 13,000 to 16,000 for cast steel, 6,000 to 8,000 for cast iron. The Stanley Electric Co. have devised a method of covering copper wire with boiled linseed oil, which they say is quite as good as double cotton covering, and takes up less space. R. B. R

1970. *Heyland's Compensated Motor.* **M. Breslauer.** (Zeitschr. Elektrotechn., Wien, 20. pp. 193–196; Discussion, p. 196, April 20, 1902.)—The paper gives a popular description of the principles of Heyland's motor, with remarks as to its use as an induction generator. In an actual case mentioned, the current taken by a motor, when running light, was reduced from 15 to 3 amperes by the compensating winding. In a footnote, the author states that a 500-kw. induction generator with Heyland compounding had been tested. The compounding was perfect with power-factors varying from 0 to 1. [See also Abstracts Nos. 2475 (1901), 199, 567, and 1237 (1902).] A. E. L.

1971. *Automatic Transformer Switch.* **D. Jakobovits.** (Zeitschr. Elektrotechn., Wien, 20. p. 181, April 13, 1902.)—The author describes an automatic switch for cutting out transformers when the secondary circuit is opened, and switching them in again as soon as the circuit is closed. A small auxiliary transformer is used, connected through a third wire with one side of double pole switches on the various current-using apparatus. On account of the need for this third wire, it is only suitable in special cases, such as groups of motors, &c. A. E. L.

ELECTRICAL DISTRIBUTION, TRACTION AND LIGHTING.

ELECTRICAL DISTRIBUTION.

1972. *Fault-Finding on Cable Networks.* **P. Charpentier.** (Écl. Électr. 29. pp. 196–205, Nov. 9, 1901.)—The author's extension of the loop method which was given in Abstract No. 1013 (1902) is summarised. The difficulty with loop methods arises from the high conductivity of the conductors, and the errors introduced by the resistance of joints. The method of Agthe described in C. H. Beçanger's book, "Essais et Verifications des Canalisations Electriques," utilises a pilot wire of opposite polarity to the main conductor. An earth on the main cable induces a short-circuit between this pilot wire and its main cable, and suitable fuses on the pilot wire enable the faulty section to be found. A fault may exist upon a cable long before the pilot wire indicates it; this is a drawback to the system. The author suggests a more elaborate system of pilot wires on which to use a loop test. M. O'G.

1973. *Continuous-Current Mains.* **J. C. A. Ward.** (Inst. Elect. Engin., Journ. 31. pp. 852–878, April, 1902.) (Discussion.) [See Abstract No. 1623 (1902).]—**A. Jamieson** recommended a compressed hard compound of mica tailings of a similar nature to that of the "Brooklyn" and "Globe" insulators for insulating cable ends in preference to corrugated ebonite. For preventing osmosis nothing surpasses several coats of the best elastic varnish. **C. D. Burnet** said that in Carlisle the Corporation contracted to supply current for traction. The negative bar was earthed at the station, as also was the middle wire of the lighting system, and here he feared that the breaking of a bond in the rails of the tramway would be deleterious to the cables if the lead sheath were continuous throughout. By cutting the lead of a long cable at intervals an opposing e.m.f. was set up between the lengths of lead, and the sum of these would be in proportion to the number of interruptions in the lead, with the result that the current would be more likely to travel along some conductor other than the cable sheath, whereas one faulty bond in a continuous lead sheath would probably burn out. **G. K. Chambers** said that electrolysis was cured by bonding the lead and earthing it. The difficulties of putting down earth-plates were small, except when the plate had to carry large currents, because the current passing from the plate to the soil tended to dry out the moisture and insulate the earth-plate. In the case of the lead sheathing, the currents were either small or only temporary. He preferred fusing distributors at the feeding-points, and dividing up the network into a number of sections, each of which was fed by a feeder, and connecting those points where the sections met through light fuses. The cost of the author's box must be high. He would be far better advised to spend the money on overground section pillars. **C. A. Henderson.**—It was cheaper to lay four extra crossings to one large 8-way box rather than to have four 4-way boxes at the four corners of two intersecting streets. The author had omitted one of the most serious faults of strained copper strip, viz., the phenomenon of "jumping" when heavily loaded suddenly by a fault. He had seen on several occasions strained strip which has been feeding a fault "jump" so badly as to release itself from the strain insulators and fall to the bottom of the culvert. **F. A. Newington.**—Ordinary short-circuits on distributing mains cleared themselves without doing much damage. A short-circuit on a feeder necessitated that feeder being switched off at the generating station, and then the fuses in the distributing mains acted, cutting off the supply in that district until the feeder was re-connected. The arrangement shown by the author did not prevent a district being cut off if a feeder broke down, therefore feeder fuses did not appear to be of much use. A disadvantage of bare strip was the great force exerted by attraction between two conductors of different polarity, in the event of a sudden rush of current. With two conductors placed 8 in. apart, if a short-circuit occurred, of, say, 5,000 amperes (which is a moderate estimate for the first second or so), there would be a pull of about 200 lbs. on each insulator. **W. A. Chamen** said that an advantage of copper strip was that one could get a real short-circuit, whereas with concentric cable a real short-circuit seldom occurred. Arcs would form and go on burning for some time before enough current would pass to blow the fuses. In the early days of the Kensington and Knightsbridge Co. lead-sheathed cables were used to connect consumers, and it was found that they were always going wrong in the walls. Miller discovered that the current was leaking over the ends on the lead passing along to the walls and there getting to earth and corroding the cable. A different trouble was that the lead sheathing of the cable came in contact with the circuit through some accident, and if the sheathing was insulated in bitumen the current might have to go along until it could find a place weak enough to allow it to jump to earth; and if in cast-iron troughs, it would burn holes in the lead at these places. That was the trouble in Glasgow. They had had to give up lead-wiped joints and their joints now were all made with compound. In his idea feeders ought to be coupled to a common network by means of non-return cut-outs at the feeder-points. It was, however, troublesome, as a manhole was not a good place for an automatic switch. **M. B. Field** wrote that he was using unusually heavy lead sheath on cables, the thickness being $\frac{3}{16}$ in. The coppers were jointed by means of copper sleeves slipped over the butted ends of the cores and soldered. This saved much time in jointing. **S. Mavor** said that indiarubber insulation was out of the question for large cables owing to its cost and non-durability. The better policy was to adopt a type which would be permanently durable. O'Gorman showed him a short time ago a very interesting cable devised for high-tension work. It was insulated in several layers. The inner layer was impregnated with an oil of relatively great capacity, and each layer successively had a smaller capacity, the result being that the stress was uniformly distributed, the advantage being analogous to that of a wire-wound gun. The advantages of triple concentric cables were: they were self-contained; there were fewer cables to handle; the cost was less; the space required was less, and therefore there was less liability to damage; there was less bonding required, and, if well done, the troubles from electrolysis would not exist; they were self-testing in a way that separate cables were not. **J. Brown** used feeders and mains of three separate armoured cables laid direct in the ground. Most of the faults had been traced to ends in manhole boxes, and were, almost without exception, on the negative conductor. **J. M. Munro** said it would be interesting to know how the author first became convinced that for the protection of lead tubes a cheap pitch compound would serve for filling troughs as well as the more expensive bitumen so long considered necessary. **Ward** did not agree with the insulating of the lead sheath. Although Burnet might obtain an opposing e.m.f. between lengths of sheath by insulating the sheathings on either side of cast-iron joint-boxes, this ingenious idea would only prevent stray currents from outside sources travelling along the lead; but these currents were not the only troubles to be contended with. Some engineers not only fused all distributors at the feeding-points, but also the feeders at the distributor bus-bar. This was not done in Glasgow, the feeder being connected by a solid link to the bus-bar. The reason was that the feeder must have not only a safe margin over the normal load on the bus-bar, but also over any extra load when a distributor fuse blew in a faulty section. In the event of a fault on the feeder it was a very remote chance that the fuse between the feeder and the bus-bar would blow. If a fault occurred on any feeders in Glasgow they relied upon the station fuses blowing, and also those on any of the distributors connecting the faulty feeder with a good one. A system of single conductors with an insulating outer sheathing, each conductor being laid in a separate channel of insulating material, was least likely to require fusing at feeding-points, for it was exceptional for heavy leaks to be possible, and faults might quite well burn themselves clear. But in a concentric lead-covered system, arcing was set up between all conductors and would burn back to the nearest joint-box. The time and material cost in manufacturing the 4-way box used in Glasgow was—

	£	s.	d.
Cast-iron box complete, with all cast-iron fittings......	8	10	0
Fuse gear, including all gun-metal fittings, and ends for four 0·25 triple concentric cables	6	0	0
Manhole cover (uncaulked, but watertight)............	2	0	0
Total complete	£16	10	0

The cost of a T-box for taking a concentric 0·06 off a 0·15 triple concentric cable was 11s. 6d. The cost of two single T-boxes for a two-wire branch on the same sizes of cables was 14s. 6d. and two boxes took up more space than one. The best coal tar pitch mixed with shale oil to soften it was quite as suitable for the solid system as the unrefined bitumen, while being one-fourth the price. Three years' experience in Glasgow had not shown the slightest deterioration of the sheathing which could be attributed to the pitch, though Trinidad bitumen was far more adhesive to the lead. The objections to pouring molten lead into the pocket of a joint-box and around the lead sheathing were: (1) The lead poured in would contract, and if metallically adhering to the sheathing would not do so to the cast-iron joint-box, and the joint would not be watertight, neither would a good bond be effected. (2) The body of lead poured in would concentrate so much heat round the sheathing that it would partially destroy it. M. O'G.

ELECTRICITY WORKS AND TRACTION SYSTEMS.

1974. *Eastern Electric Light Co., Paris.* **H. Martin.** (Génie Civil, 41. pp. 17–23, May 10, 1902.)—This company carries on electric lighting in the eastern suburbs of Paris, and has built a central station at Alfortville, whence current is supplied at 5,000 volts to various substations. The station at Alfortville is on the banks of the Seine, and is built on piles. It contains six boilers, each giving 3,120 kg. of superheated steam per hour, the gases being passed through an economiser of 228 tubes, and into a chimney 50 m. high and 2·5 m. in diameter. The engines are of the horizontal compound tandem type by Carel of Ghent; they give 700 b.h.p. at a speed of 100 r.p.m., the cylinders being steam-jacketed. The three-phase Alioth alternators give

540 kw. at 5,250 volts, the power-factor being taken as 0·75, and the frequency 50. The diameter of the rotating portion is 5·1 m., and its weight is 38 tons. The excitation of the machines is effected by dynamos driven by three-phase motors; these dynamos also light the building and drive various pumps, the current being supplied at 125 volts. There is also a battery of accumulators giving 40 amperes for 10 hours. The bus-bars are constructed on the ring principle, and various removable connections render it possible to isolate a section for the purpose of repairs. The substation at Ivry replaces a station which has hitherto generated continuous current, and the municipal authorities required the supply to be continued on the same principles. The frequency of 50 being considered too high for rotary converters, asynchronous motor-generators were adopted. Three of the machines consist of a motor, taking current at 5,000 volts, coupled to a dynamo giving 100 kw. at 250 volts and also to a small booster for charging the accumulators. The fourth group consists of a motor coupled to two dynamos, each giving 100 kw. at 250 volts. Current is supplied to consumers on the three-wire system, with a pressure of 500 volts between the outer conductors. The batteries in this station give 70 amperes for 5 hours. The substation at St. Maur replaces one which has generated alternate current at 3,000 volts; this pressure has been maintained, transformers being installed to change from 5,000 to 3,000 volts. This pressure is then transformed to 110 volts for purposes of distribution. Other districts are supplied with current at 125 volts, furnished by transformers in substations. The article contains drawings of machinery, switchboards, &c.

W. H. S.

ELECTRIC TRACTION AND AUTOMOBILISM.[1]

1975. *Energy and Motor Capacity in Railway Operation.* **C. T. Hutchinson.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 117–152, Feb., 1902.)—The author works out the solution of various electric railway problems (for suburban lines), chiefly analytically. The case is taken of uniform acceleration followed by coasting and braking, the complete solution of which is reduced to three equations. All the terms in these equations are functions of the three accelerations, except one which is the average velocity divided by the total time from start to rest between two stations; this term the author calls the "through acceleration." The paper does not lend itself to abstracting, as it consists largely of equations illustrated by curves of particular cases. After giving the general equations the author passes on to schedule speed and motor curves. He finds that the values of torque and speed in terms of input are nearly the same for motors of different size and make. Then follow expressions and curves giving power, energy and distance in terms of time. The author finally considers motor capacity and heat losses. It is assumed that the motor operates at the rated capacity on a one-hour basis (heating to 75° C.) at the moment when all resistance is cut out and the motor begins to run on the motor curve. The capacity of the equipment (commutation being the limit) is found to be as follows:—

Acceleration in miles per hour per sec.......	0·5	1	1·5	2	3
Capacity in kw. per ton	14·9	25·5	36·3	47	68

Actual measurements show that the average core loss in tramway motors at the rated output is 3·4 per cent. and the average copper loss 3·6 per cent.

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[1] Non-electrical Automobiles are described in the section dealing with steam and gas engines.

Approximately a motor will carry its rated output for 25 per cent. of the total time. The above total loss is 12 per cent.; hence a motor can dissipate continuously 3 per cent. of its rated capacity. If this is regarded as a limit in addition to commutation then the figures given above for capacity of motor equipment become modified to some extent. High acceleration means a great increase in weight of motor equipment, and this again influences the energy required. The capacity of the equipment is proportional to the square root of the distance between stations. The author concludes that the acceleration which gives the lowest motor capacity is the most economical, the energy being less for the lower accelerations. He considers that the proposed express service of the New York Rapid Transit Line is an impossibility, the weight of the motors being prohibitive. W. R. C.

1976. *Selection of Electric Motors for Railway Service.* **W. B. Potter.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 157–165, Feb., 1902.)—The author criticises the average figures taken for losses given in the preceding Abstract, pointing out that the limits vary very much in practice. Owing to the complex character of the losses, motors cannot be well compared by running for an hour on an arbitrary voltage. For a given service the speed curves should be first determined and thence the losses from the resistance and core loss curves. The most accurate method is, of course, to mount the motors on a car and to run them under the required conditions. A table is given showing the capacity for a safe temperature of a 38-h.p. motor with different stops per mile, gear ratio and tons per motor. W. R. C.

1977. *Electric Traction.* **P. Dawson.** (Elect. Rev. 50. pp. 788–789, May 9; 833–834, May 16; and pp. 874–875, May 23, 1902. Paper read at Northampton Town Hall.)—The author gives figures which may be used for estimating purposes in connection with tramway work. He also gives tables showing the amount of capital already spent on the various tramways in England, and the financial and other results obtained in twelve of the largest towns. Another table gives figures showing the capacity of plant installed in various towns to supply the tramways, and other useful particulars are also given. W. H. S.

1978. *Acceleration on the Liverpool Overhead Railway.* (Electrician, 49. pp. 373–375, June 27, 1902.)—An important change of equipment has been made so as to increase the acceleration on the line. With the old system, the entire distance of 6½ miles was run in 32 minutes including 16 stops, or practically at a scheduled speed of 12¼ miles an hour. This requires a minimum of 14 trains running at five-minute intervals to cope with the traffic. The new equipment is guaranteed to run the whole distance, including the 16 stops each of 12 seconds, in 20·9 minutes, which is equivalent to a scheduled speed of 19 miles an hour. The weight of the train, including 154 passengers, is 55 tons. Tests show that the journey is easily made under 20½ minutes. Curves are given which show that the acceleration reached 4·2 ft. per second per second, or nearly 3 miles per hour per second, thus enabling the train to cover the 2,110 ft. between the stations in little over one minute, including starting and stopping. This rapid acceleration is attributed to the excellent commutation of the motors, which will not spark when carrying 400 amperes, which is four times their normal current. The curves also show that the retardation of the brakes is satisfactory. The negative acceleration reached 4·7 ft. per second per second. The frequent stopping of trains running at high-schedule speed will consume from 120 to 150 watts per ton-mile. If the stops are far apart, the watts required are from 90–100 per ton-mile. In the experiments recorded, the watts consumed were 137 per ton-mile, which is equivalent to about 6·35 kw. per train-mile.

The following table shows the comparison between the old and the new systems :—

	Old System.	New System.
Mean speed	12½ miles = 20 km.	19½ miles = 31 km.
Number of stops	16	16
Mean time at stations......	11 seconds	11 seconds
Mean distance between stations	729 yds. = 666 m.	729 yds.
Watts per ton-mile......	110	137
Acceleration..................	1·6 ft. = 0·44 m. per sec. per sec.	3 ft. = 0·91 m. per sec. per sec.
Retardation	3 ft. = 0·91 m. per sec. per sec.	4·8 ft. = 1·26 m. per sec. per sec.

Each of the new trains is fitted with four 100-h.p. railway motors designed by S. H. Short, and built at the works of the English Manufacturing Company at Preston. The efficiency at full load is 93 per cent. The temp. rise after one hour's full load is as follows :—
Commutator, 55° C. ; armature, 39° C. ; fields, 57° C. ; pinion bearing, 14° C. ; commutator bearing, 9° C. The complete motor weighs 4,387 lbs., made up as follows :—Motor, 3,945 lbs. ; gear, 260 lbs. ; housing, 140 lbs. ; links, 40 lbs. ; and key, 2 lbs.

Twelve trains of the new type will replace fourteen of the old type. With the previous equipment, the trains ran 144 train-miles per hour, while in the new method they will run 216 train-miles per hour. The five-minute heading between the old trains will be reduced to 3½ minutes. This means that the journey will be made in two-thirds of the time previously taken. Numbers are given contrasting Liverpool and other electric lines :—

	Miles per hour, including stops.
Liverpool Overhead Railway	19
Manhattan Elevated, New York..............................	13·5
Metropolitan „ „	14·1
South Side „ Chicago.................................	14·6
Lake Side „ „	12·5
City and South London	12·5
Central London	14

[See also Abstracts Nos. 601 and 1597 (1900), 2043 (1901).] W. W. H. G.

1979. *Electric Traction on Steam Railways in Italy.* **C. A. Carus-Wilson.** (Inst. Elect. Engin., Journ. 31. pp. 1091–1110 ; Discussion, pp. 1110–1120, June, 1902.)—The author describes the work which has been done by the Adriatic and Mediterranean Railway Companies in equipping portions of their lines electrically. On the former railway the portion from Lecco to Colico, and thence to Sondrio and Chiavenna, is worked on the three-phase system with polyphase motors at 3,000 volts, there being two trolley lines with the rails as third conductor. The system will be extended to Milan. The hydraulic power-house is at Morbegno. The Mediterranean

Railway Company has electrically equipped the line from Milan to Gallarate and thence to Varese, Porto Ceresio, Laveno, and Arona. The power-house at Tornavento is not yet complete, steam generating plant being used temporarily. This system is worked by rotary converters supplying current at 650 volts. [See also Abstracts Nos. 1377 (1900) and 2294 (1901).] The following table compares the weight, power, and dimensions of the polyphase motor cars on the Lecco line with the direct-current motor cars on the Varese line :—

	Total Weight Empty.	Length of Frames.	Seats.	No. of Motors.	Maximum h.p. of each.	Total Maximum H.P.	Weight of Four Motors.	Full Speed on Level.
	Tons.	Feet.					Tons.	M.P.H.
Varese	40	52	63	4	150	600	10	56
Lecco	53	57	56	4	2 of 150 2 of 75	300	15·2	37

The trains consist of two carriages, and run at much more frequent intervals than was thought desirable under the steam system. This increase in the service, together with a reduction of fares, is expected to result in a much larger traffic. The extent to which the traffic was likely to be increased was experimentally tested on the line from Bologna to St. Felice with cars fitted with accumulators. The speed and the frequency of the trains were both doubled, and the fares reduced to 40 per cent. of their original amount. The result has been that the passenger traffic has increased fivefold and the receipts have been doubled. The author compares the conditions of running an electric service in England and Italy, and, assuming that twenty-eight short trains are run each way per day over a certain line instead of eight longer ones, he calculates that the working expenses would be increased by £360 per mile per annum. This, together with interest on the cost of construction, which is taken at £8,000 per mile, amounts to an increase of £640 per mile per annum. On the Great Northern Railway the passenger receipts are 43d. per train-mile, and the passenger traffic would have to increase 61 per cent., if the fares were unaltered, in order to meet the increased expenses. The author's contention is that electricity will not help the railways by reducing their expenses, but by enabling them to offer increased travelling facilities at a figure impossible with steam traction. The paper contains a large number of figures dealing with running expenses, receipts and expenses per mile of line in England and Italy, fares in Italy, and the cost of working steam and electric trains in England and Italy.

W. H. S.

1980. *Edmondson's Automatic Locking Signals.* (Elect. Engin. 29. pp. 906–907, June 27, 1902.)—To provide a block system on electric tramways and railways, a short brass bar held by springs fixed near to, but insulated from, the ear or bracket, is caused to make contact with the trolley head as the car travels. Such a contact operates a relay switch contained, with the necessary iron cores and solenoids, in a box attached to the pole, alongside of which are the semaphore arm and bull's-eye. At the entrance to a block section (protected by one semaphore at each end), the first contact puts the distant arm to

"Danger," the second contact, just ahead of the first, puts the near arm to "Danger," and thus the section is blocked except for the car then travelling upon it. This car, upon reaching the end of this section, is caused, by means of its trolley head, and by means of appropriate circuits, to lower the signal at entrance to this section, and thus to clear it for another car. Exactly similar arrangements exist for a car coming in the opposite direction on the same pair of rails from a passing-place. Matters are so contrived that when both cars simultaneously endeavour to enter one and the same section each home signal goes to "Danger" and signifies the positions of the cars to the driver. The car that has to back out would then automatically release the semaphore opposing the movement of the other car, and the latter would proceed as usual. The mechanism and the lamps are run off the trolley-wire current. E. O. W.

1981. *Tram-Rail Drilling Machine.* (Engineer, 93. p. 430, May 2, 1902.)—A machine is here described which was made by Buckton for the North-Eastern Steel Co. It has four spindles and drills four holes simultaneously. In drilling fishplate bolt-holes, two are drilled from one side and two from the other, and in this way the pressure is equalised. The drills are formed from rectangular steel, sharpened at the ends and the sides; in this way, when the drills are through the rail, it can be advanced longitudinally against the sides of the drills, and the holes are made oval. The machines are used in pairs, and the two drill holes at opposite ends of the rail simultaneously.

W. H. S.

1982. *American Tramway Practice.* **J. B. Hamilton.** (Tram. Rly. World, 12. pp. 88–90, July 5, 1902. Paper read before the Association of Municipal Tramway Managers, July, 1902.)—*Track Maintenance.*—The author contrasts the general state of American roads with English. *Cast Welded Joints.*—After two years' wear these presented a good surface appearance, but American opinions differ as to this practice. *Electrically Welded Joints.*—In Buffalo there are about 30,000 of this type on about 109 miles of track. The cost per joint is about £1, and this method has given great satisfaction. The disadvantages are the time the tracks are out of service during reconstruction or welding. An electric welding plant occupies the track night and day during the welding process. *Continuous Rail Joints* are largely used for repair work. *Care of Car Equipment.*—Great diversity of practice. In some places cars are inspected every three or four days, and overhauled every two months, whilst in other places it is considered sufficient to inspect them once a week, and to overhaul them only when armature bearings need renewing. Generally speaking, one man attends to seven cars. Except for trifling repairs, all cars are sent from the various depôts to a central repairing works. In most cities the electrical repair work is done on "piece," and in Brooklyn the overhauling of the trucks is also done on stated terms. The following are the Brooklyn rates: Overhauling trucks, about $2; overhauling motors, $1; replacing wheels, 50 c.; replacing pony wheels of double truck, 30 c.; replacing brake beams, 40 c.; replacing brake shoes, 60 c. Closer supervision than in this country is, of course, necessary. *Power Stations.*—Except on the New York Metropolitan Railway, where three-phase current is generated, the principal cities generate continuous current, but the intention is to adopt three-phase for future work. The method of "transportation," that is, the routine of the motorman and conductor's duties, is touched upon. The maximum speeds are not greater in America than here, but the average speed is higher, owing to more rapid acceleration. F. B.

ELECTRIC LAMPS AND LIGHTING.

1983. 220-*Volt Lamps.* **F. W. C. Bailey.** (West. Electn. 30. p. 425; Discussion, pp. 425–426, June 14, 1902. Abstract of paper read before the National Electric Light Association at Cincinnati, Ohio, May 22, 1902.)—The author gives the results of his tests on 16-c.p. lamps at 220 volts, at least 50 of each make being examined for the purpose of forming an average. Three-fourths of the makers used the double-oval shape of filament. The following table summarises the results:—

EFFICIENCY TABLE FOR HORIZONTAL AND SPHERICAL CANDLE-POWER.

Lot.	Type of Filament.	Average Watts per Initial Mean Spherical Candle-power.	Average Watts per Initial Mean Horizontal Candle-power.	Average Watts per Mean Spherical Candle-power during Useful Life.	Average Watts per Mean Horizontal Candle-power during Useful Life.	Average Watts per Mean Spherical Candle-power during Test of 1,500 Hours.	Average Watts per Mean Horizontal Candle-power during Test of 1,500 Hours.
A	Double oval	4·88	4	5·37	4·40	6·09	4·99
B	" "	4·73	3·89	5·45	4·5	6·99	5·77
C	" "	4·66	3·83	5·15	4·23	5·94	4·89
D	" "	4·87	4·04	5·23	4·34	6·15	5·10
E	" "	4·16	3·39	4·61	3·76	6·21	5·06
F	Three-coil ellip. spiral ...	5·52	5·3	6·12	5·88	6·33	6·08
G	Two loops in series	4·98	4	5·47	4·39	6·23	5
H	Double oval	5·42	4·45	5·95	4·89	6·2	5·09
I	" "	4·81	3·98	4·96	4·10	6·28	5·20
J	" "	4·53	3·67	5·06	4·10	5·96	4·83
K	" "	4·77	4·05	5·28	4·88	6·13	5·20
L	" "	5·00	4·07	5·42	4·5	7·18	5·85
M	Two ovals in series	4·87	4·06	5·67	4·73	6·27	5·23
N	Two-coil spiral in series	3·99	3·36	4·38	3·73	5·1	4·38

The report of the paper is much condensed; but it would appear that the useful life of lot N was considered to be 467 hours, which is as good as that of a 100-volt lamp taking initially 3·1 watts per c.p. Reference is made to a preceding communication to the Association by F. W. Willcox, who also explained in the discussion the method used for determining the figures relating to mean spherical candle-power. W. H. S.

REFERENCE.

1984. *Graphical Solution of Network Problems.* **B. Soschinski.** (Elektrotechn. Zeitschr. 23. pp. 359–362, April 24, 1902.)—In the graphical representation of the fall of potential along a distributor, it is more convenient to use for abscissæ actual distances, and not mere resistances. The author investigates the modification of the diagram due to this change, assuming a distributor of varying cross-section, and considering a number of standard cases. The paper does not admit of a useful Abstract. A. H.